SA 1239G

Service Manual

Allison Transmissions

V-DRIVE MODELS

VH 2, 4, 5, 7, 9
VS 1-8, 2-6, 2-8

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V-DRIVE AUTOMATIC TRANSMISSION

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B, 14. Drive clutch control valve assembly (VH, VS series)

15. Splitter clutch control valve assembly (VS2 series)

Section 1. GENERAL INFORMATION

1-1. SCOPE OF MANUAL

a. Coverage

(1) This Service Manual covers the description, operation, maintenance and overhaul of the VH and VS series coach transmissions (fig. 1-1 through 1-4).

(2) All text and illustrations in this manual are applicable to both the VH and VS series unless specifically designated.

b. Arrangement

(1) Eight sections. This manual consists of eight sections. Each paragraph and illustration number is prefixed with the applicable section number.

(2) Section content. Section 1 contains general information, specifications and data. Section 2 describes transmission components and explains their operation. Section 3 outlines preventive maintenance procedures. Section 4 contains general information on overhaul procedures. Section 5 covers disassembly of the transmission into subassemblies. Section 6 covers rebuild of the subassemblies. Section 7 covers assembly of the transmission from subassemblies. Section 8 covers wear limits and spring specifications.

(3) Foldout illustrations. Foldout illustrations at the back of the manual include cross-section views, hydraulic schematics and exploded views showing all parts in their assembly relationship.

c. Maintenance Information. Each task outlined in this Service Manual has been successfully accomplished by service organizations and individuals. It is not expected that every service organization or individual will possess the required special tooling, training, or experience to perform all the tasks outlined. However, any task outlined herein may be performed if the following conditions are met:

(1) The organization or individual has the required knowledge of the task through:

Formal instruction in a DDA or Distributor training facility.

"On-the-job" instruction by a DDA or Distributor representative.

Experience in performing the task.

(2) The work environment is suitable to prevent contamination or damage to transmission parts or assemblies.

(3) Required tools and fixtures are available as outlined in the Service Manual.

(4) Reasonable and prudent maintenance practices are utilized.

Note: Service organizations and individuals are encouraged to contact their local DDA Distributor for information and guidance on any of the tasks outlined herein.

1-2. MODEL SERIES DIFFERENCE

a. Two Series. Coach service which requires low-speed runs with frequent stops use the VH, and VS1 models. Coach service which includes longer, higher-speed runs between stops use the VS2 model.

b. Difference. The major differences in design, between the three models, are in the drive clutches and the inclusion of a splitter overdrive arrangement in the input of the VS2 series. These differences can be seen in foldout 1 and foldout 2. Foldouts 3 through 8 illustrate differences in the hydraulic systems in all the series.

1-3. SUPPLEMENTARY INFORMATION

Supplementary information, to be used in conjunction with this Service Manual, will be

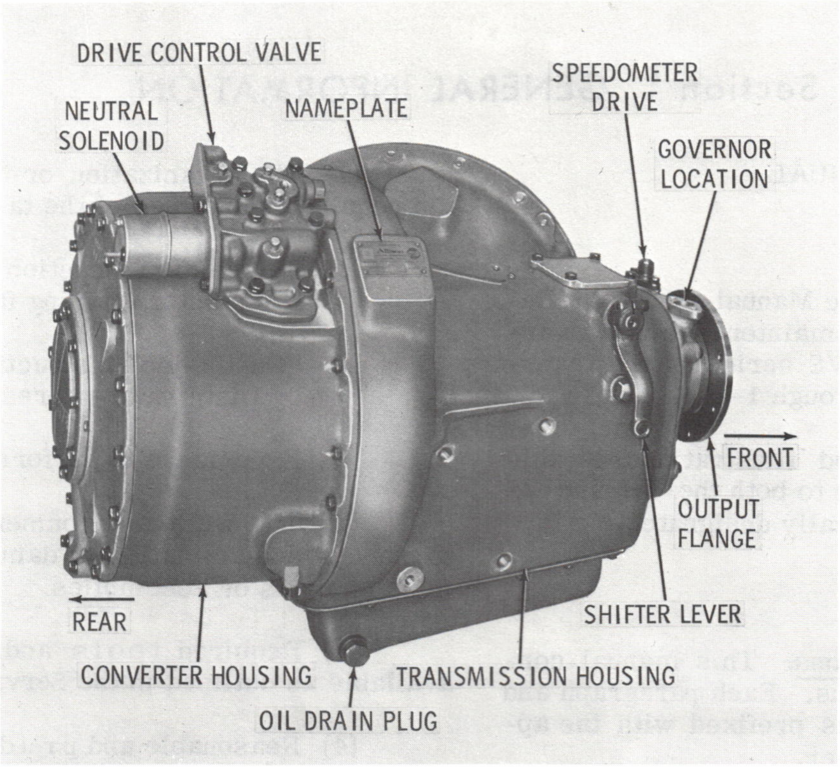

Fig. 1-1 Model VH9, VS1-8 transmission—right-rear view

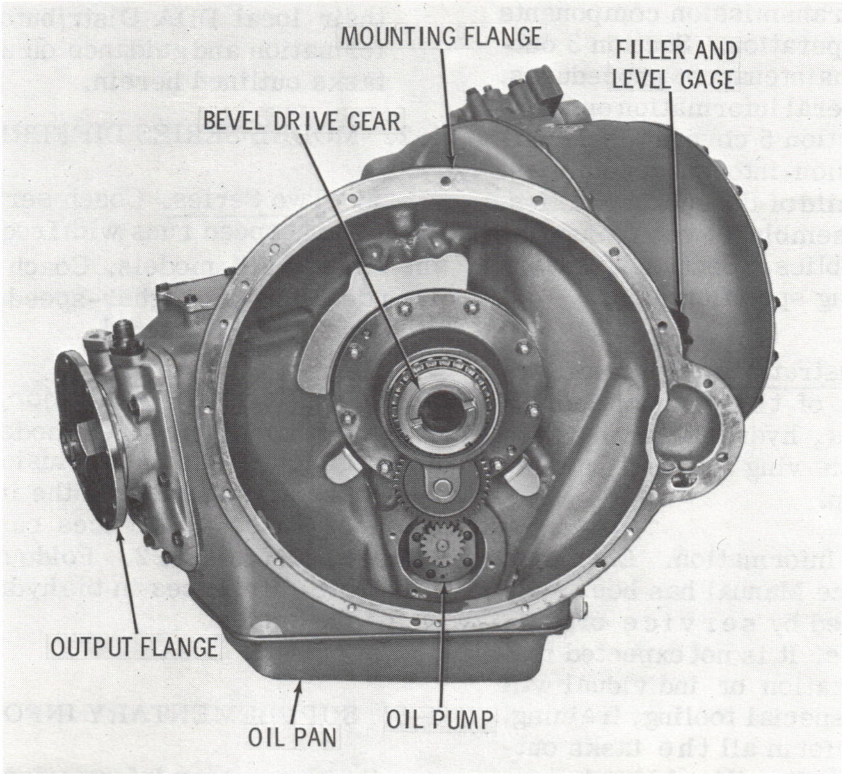

Fig. 1-2 Model VH9, VS1-8 transmission—left-front view

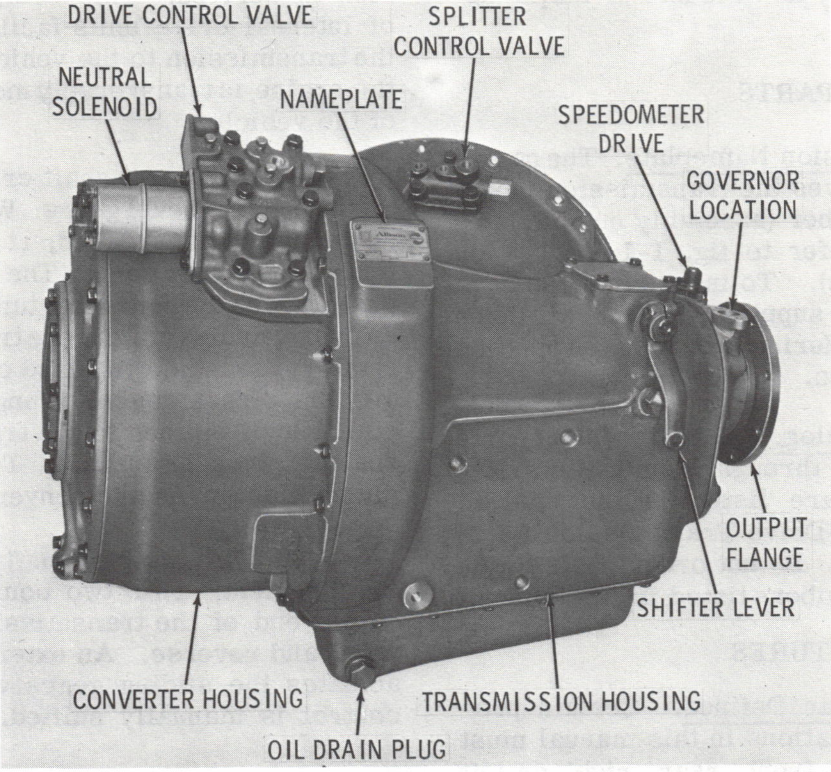

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Fig. 1-3. Model VS2-6 transmission—right-rear view

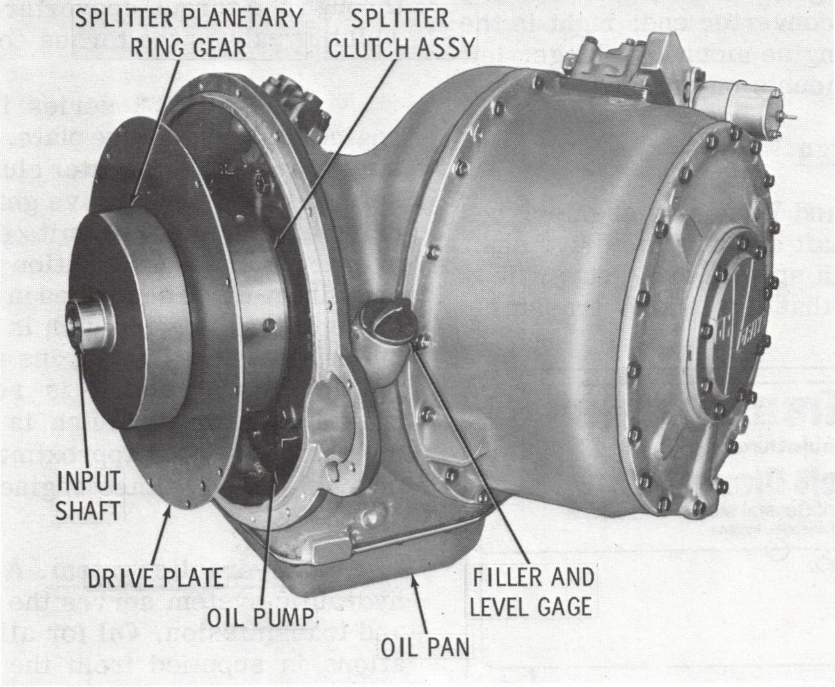

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Fig. 1-4. Model VS2-6 transmission—left-rear view

issued to cover any new models or major design changes.

1-4. ORDERING PARTS

a. Transmission Nameplate. The nameplate (fig. 1-5) gives the transmission model number, part number (assembly number) and serial number (refer to fig. 1-1 and 1-3 for nameplate location). To insure that the correct parts will be supplied, furnish all three numbers when ordering parts or requesting service information.

b. Parts Catalog. All replacement parts should be ordered through your dealer. Replacement parts are listed in the current General Motors V-Drive Transmission Parts Catalog (SA 1238). Do not order parts by illustration item numbers listed in this manual.

1-5. DESIGN FEATURES

a. Front, Rear Defined. Certain procedures and explanations in this manual must make reference to front, rear, right or left of the transmission. These references are not to be associated with such terms relating to the vehicle. The front of the transmission is at the output flange location (fig. 1-1). The rear is the torque converter end; right is the side opposite the engine mounting flange; left is the side which mounts on the engine.

b. Basic Design

(1) The VH and VS series are designed so that the input shaft engages the drive shaft at an angle, through spiral bevel gears. It is from this feature that the term V transmission is derived. This compact arrangement of internal drive units facilitates coupling of the transmission to the vehicle driveline when the engine is transversely mounted in the rear of the vehicle.

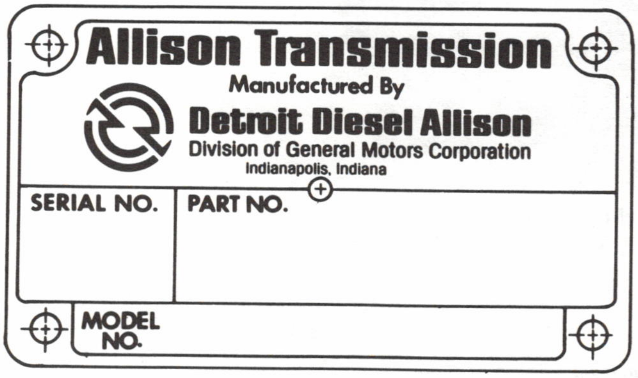

Fig. 1-5. Transmission nameplate

(2) The input shaft drives two clutches through spiral bevel gears. When the hydraulic drive clutch is engaged, its hub drives the torque converter pump. The torque converter pump drives the converter turbine and, through an over-running clutch, the transmission drive shaft. When the hydraulic clutch is released and the direct clutch is engaged, the direct clutch hub, splined to the transmission drive shaft, drives this shaft. The over-running clutch disengages and converter action stops.

(3) The output shaft, a sliding gear arrangement, and two countershafts at the output end of the transmission, provide forward and reverse. An external shifter lever actuates the sliding gears when the driver's control is manually shifted.

(4) The VH, VS1 series is coupled to the engine through a shaft splined directly to the bevel drive gear. The VH, VS1 series has only two drive modes — hydraulic drive through the torque converter or direct drive which bypasses the torque converter.

(5) The VS2 series is coupled to the engine through a drive plate, a splitter planetary gear set, two splitter clutches and a shaft splined to the bevel drive gear. This splitter drive arrangement permits either a direct or overdrive input, in addition to the converter and direct drive described in (4), above. When the splitter direct clutch is engaged, the input shaft rotates at engine speed. When the splitter direct clutch is released and the splitter overdrive clutch is engaged, the input shaft rotates at approximately 1.3 (VS2-6) or 1.45 (VS2-8) times engine speed.

c. Hydraulic System. A single, integral, hydraulic system serves the torque converter and transmission. Oil for all hydraulic operations is supplied from the same sump (oil pan). Oil pressure required for the various hydraulic operations is supplied by the input driven oil pump.

d. Hydraulic, Electrical Controls

(1) Both the VH and VS series have clutches which are hydraulically controlled and a control system which is a combination of hydraulic and electrical circuits.

(2) A hydraulic pressure produced in the governor, driven by the transmission output shaft, determines the operating mode. The governor, in the VH series, controls the drive control valve which selects hydraulic drive or direct drive. The governor, in the VS2 series, controls both the drive control valve and the splitter clutch control valve in sequence. These valves select hydraulic drive, direct drive and splitter direct drive and overdrive.

1-6. OPERATING INSTRUCTIONS

Refer to vehicle operating instructions.

1-7. TOWING OR PUSH STARTING

The engine cannot be started by pushing or towing. Before pushing or towing a disabled vehicle more than one-half mile, remove the axle stub shaft from the drive wheels. Cover the hub openings to prevent loss of lubricant and entry of dust and dirt. Also provide an auxiliary air supply to the vehicle to actuate the brakes.

1-8. SPECIFICATIONS AND DATA

The following specifications and data apply to the VH and VS transmissions. Unless specifically designated, information is applicable to both models.

SPECIFICATIONS, DATA

Transmission type	Torque converter, V drive

Rating:	VH	VS1-8	VS2-6	VS2-8
max input speed	2100 rpm	2100 rpm	2100 rpm	2100 rpm
max net input torque	600 lb ft	750 lb ft	600 lb ft	750 lb ft
max net input power	198 hp	259 hp	198 hp	259 hp

Rotation:	
input (viewed from input side)	counterclockwise
output (viewed from output end)	clockwise
Mounting	modified SAE flange on converter housing bolts to engine flywheel housing
Gear ranges (forward):	
VH series	1 (hydraulic or direct drive)
VS2 series	2 (hydraulic or direct drive in first gear; splitter overdrive in second gear)
VS1 series	1 (hydraulic or direct drive)
Manual selector positions	Forward, neutral, reverse
Torque converter:	
type	2-stage, 1-phase, 3-element
torque ratio (at stall)	3.75:1

Component ratios

Model	Bevel gears	Splitter	Reverse
VH	1.04	—	0.96
VH1-8	0.87	—	0.96
VS2-6	1.04	0.77	0.96
VS2-8	0.87	0.69	0.96
VS2-8	1.04	0.69	0.96

Overall ratios

Model	First gear Mechanical	Second gear Mechanical	Reverse gear Mechanical
VH	1.04:1	—	1.00:1
VS1-8	0.87:1	—	0.85:1
VS2-6	1.04:1	0.80:1	1.00:1
VS2-8	0.87:1	0.60:1	0.85:1
VS2-8	1.04:1	0.72:1	1.00:1

Gearing:	
splitter (input of VS series)	straight-tooth planetary
bevel	spiral
reverse	straight-tooth spur, countershaft
Clutches:	
VH series (2 clutches):	
hydraulic drive	cone-type, oil-wetted, hydraulic-applied
direct drive	multidisk, oil-wetted, hydraulic-applied
VS1 series (2 clutches):	
hydraulic drive	multidisk, oil-wetted, hydraulic-applied
direct drive	multidisk, oil-wetted, hydraulic-applied
VS2 series (4 clutches):	
hydraulic drive, direct drive, splitter overdrive	multidisk, oil-wetted, hydraulic-applied
splitter direct drive	multidisk, oil-wetted, spring-applied

SPECIFICATIONS AND DATA — Continued

Oil system:	
oil pump	2-gear, positive displacement
sump	integral
oil specification:	
above -30°F (-34°C)	Dexron® or Dexron II® transmission fluid
below -30°F (-34°C)	Dexron® or Dexron II® transmission fluid (auxiliary preheat required to raise temperature in the sump to a temperature above -30°F)
oil capacity (total system):	
all models	initial fill — 28 to 32 US quarts (26 to 30 liters) depending upon installation
oil filters (1 on VH series; 2 on VS series)	full flow (furnished by customer)
oil cooler (heat exchanger)	external (furnished by customer)

	VH	VS2	VS1
Temperatures, pressures:			
max oil temp	250°F (121°C)	250°F (121°C)	250°F (121°C)
normal operating temp	180 to 200°F (82 to 93°C)	180 to 200°F (82 to 93°C)	180 to 200°F (82 to 93°C)
main oil pressure:			
at idle (450 engine rpm)	50 psi (345 kPa) min	50 psi (345 kPa) min	50 psi (345 kPa) min
at 2140 engine rpm	80 to 100 psi (552 to 690 kPa)	80 to 100 psi (552 to 690 kPa)	80 to 100 psi (552 to 690 kPa)
converter-in pressure:			
at idle (450 engine rpm)	12 psi (83 kPa) min	7 psi (48 kPa) min	7 psi (48 kPa) min
at 2140 engine rpm	45 psi (310 kPa) min	45 psi (310 kPa) min	45 psi (310 kPa) min
converter-out pressure:			
at full-throttle stall	55 psi (379 kPa) min	55 psi (379 kPa) min	55 psi (379 kPa) min
at idle (450 engine rpm)	12 psi (83 kPa) min	7 psi (48 kPa) min	7 psi (48 kPa) min
lubrication	—	8 psi (55 kPa) min	6 psi (41 kPa) min

Speedometer drive:	
type	SAE 5/32 heavy duty
ratio	1 x transmission output speed
Dimensions, weights:	
length, overall	33.33 in. (847 mm)
weight, dry (VH series)	539 lb (244.5 kg)
weight, dry (VS2 series)	595 lb (269.9 kg)
weight, dry (VS1 series)	539 lb (244.5 kg)

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Section 2. DESCRIPTION AND OPERATION

2-1. SCOPE OF SECTION 2

This section describes in detail, and explains the function of the transmission components. Hydraulic circuits and torque paths are explained and illustrated. Three series are covered — VH, VS1 and VS2. All text and illustrations in this section are applicable to all the V series, unless specifically designated.

2-2. MOUNTING AND INPUT DRIVE

a. VH and VS1 Series

(1) The transmission housing is bolted to the engine flywheel housing. Other mounting points are determined by the specific mounting method employed by the vehicle manufacturer.

(2) A flexible coupling, equipped with damper springs, is bolted to the engine flywheel. An input shaft, splined at both ends, connects the flexible coupling hub to the bevel drive gear in the transmission. The flexible coupling and the input shaft are not furnished as parts of the transmission.

b. VS2 Series

(1) The transmission housing is bolted to the engine. The bolts pass through an adapter located between the transmission housing flange and the engine flywheel housing. Other mounting points are determined by the specific mounting method employed by the vehicle manufacturer.

(2) In VS2-6 models, a drive plate 8 (A, foldout 9) is bolted to the engine flywheel. In VS2-8 models, a splined drive plate assembly 9 engages a torsional isolator which is bolted to the engine flywheel. A planetary carrier assembly (items 3 through 7) is bolted to the drive plate. A planetary ring gear 1, in mesh with carrier pinions 6, rotates freely in a bore in the engine flywheel. A splined input shaft 23 (B, foldout 9) connects the planetary ring gear to the internal splines of bevel drive gear 34 in the transmission. Sun gear assembly 13, (A, foldout 9) for the input planetary, is attached to the front of the splitter clutch assembly.

2-3. SPLITTER CLUTCHES (VS2 series)

a. Two Input Speeds (A, foldout 9)

(1) The two multiplate splitter clutches control the input speed of the transmission. The splitter direct drive clutch, when engaged, locks ring gear 1 and sun gear assembly 13 of the input planetary together. This causes the input shaft (splined into the bevel drive gear) to rotate at engine speed.

(2) When the splitter overdrive clutch is engaged, the splitter clutch housing and planetary sun gear are stationary. Input carrier pinions 6, in mesh with the stationary sun gear, overdrives ring gear 1. This causes the ring gear, input shaft and bevel drive gear to rotate at faster than engine speed.

b. Engagement of Splitter Clutches (A, foldout 9)

(1) The splitter direct drive clutch is engaged any time the transmission output speed is below a predetermined point. This is due to the constant pressure of disk-type spring 29 acting against pressure plate 23.

(2) The splitter overdrive clutch engages (and the splitter direct drive clutch releases) when hydraulic pressure moves splitter clutch piston 44. This occurs when the transmission output has reached a desired speed. The increase in transmission output speed increases governor pressure which

shifts the splitter clutch control valve, thus directing the hydraulic pressure to move the clutch piston.

2-4. MATCHED BEVEL GEAR SET

a. VH, VS1 Series (A, foldout 10)

(1) The input drive consists of a matched set of spiral bevel gears (14), which transmits the input torque to the drive clutches, torque converter and drive shaft. Each set of bevel gears form an output gear ratio, which is determined by their number of teeth. The VH series with a 23-tooth drive and a 24-tooth driven gear, form a 1.04 to 1 output ratio. The VS1 series with a 24-tooth drive and a 21-tooth driven gear, form a 0.87 to 1 output ratio. Through each of these combinations, the required torque is produced.

(2) The drive gear is supported on two tapered roller bearing assemblies 25 and 31. The driven gear is keyed to bevel gear sleeve 45, supported by two ball bearings 37 and 39. Both gears are shimmed to establish the proper position and backlash.

b. VS2 Series (B, foldout 9)

(1) This transmission series uses either one of two bevel gear sets to produce the desired speed ratio. A speed reduction ratio of 1.04:1 is produced by a 23-tooth drive gear and a 24-tooth driven gear. An overdrive ratio of 0.87:1 is produced by a 24-tooth drive gear and a 21-tooth driven gear. Either gear set transmits the torque to the drive clutches, torque converter, and drive shaft.

(2) The drive gear is supported on tapered roller bearing assemblies 16 and 22. The driven gear is keyed to sleeve 37, which is supported by two ball bearings 29 and 34. Both gears are positioned by shims to establish proper backlash and gear tooth contact.

2-5. DIRECT, CONVERTER DRIVE CLUTCHES

a. VH Series Drive Clutches. The direct drive clutch and the hydraulic drive clutch are attached to bevel gear sleeve 37 (A, foldout 10) through drive plate assembly 1 (B, foldout 12). The direct drive clutch is a multiplate clutch. VH4, VH5 and VH9 models include plates 10 and 11. VH2, VH6 and VH7 models include plates 45, 46, 47 and 48. The hydraulic drive clutch is a cone-type clutch. Both clutches are actuated by hydraulic pressure and released by spring pressure. When the direct drive clutch is engaged, the bevel driven gear is locked to drive shaft 3 (B, foldout 13). When the hydraulic drive clutch is engaged, the bevel driven gear drives torque converter pump 15 (A, foldout 13).

b. VS Series Drive Clutches (A, foldout 12). The direct drive clutch and the hydraulic drive clutch are attached to the bevel gear sleeve through direct drive clutch cover 2 and clutch drum 12. Both are multiplate clutches, actuated by hydraulic pressure and released by spring pressure. When either of these clutches is engaged, the action is the same as in the VH series (a, above).

2-6. TORQUE CONVERTER

a. Components (A, foldout 13)

The torque converter operates as a hydraulic torque multiplier and a hydraulic coupling. The torque converter is a 3-element arrangement consisting of pump 15, turbine 16 and stator vanes, integral with cover 21.

b. Operation of Torque Converter. The three torque converter elements operate in oil. The pump is driven by the bevel driven gear, through the hydraulic clutch. Vanes of the pump direct oil against the vanes of the turbine first stage, causing the turbine to rotate. The stator redirects the oil into the turbine second stage. From the turbine, oil returns to the converter pump. When the oil re-enters the pump, its unexpended energy helps drive the pump.

c. Over-running Clutch (B, foldout 13). The over-running clutch assembly 7, between the torque converter turbine element and drive shaft 3, transmits torque from the turbine to the drive shaft when the hydraulic drive clutch is engaged. When the direct drive clutch is engaged, the drive shaft over-runs the torque converter, leaving it inactive.

2-7. DRIVE SHAFT, OUTPUT INTERMEDIATE GEAR

a. Main Power Member. Drive shaft 3 (B, foldout 13) is the main power transmitting member which connects the bevel driven gear, the drive clutches and the torque converter to the output components. It is splined to the inner member of the over-running clutch, the direct drive clutch hub, and output intermediate gear 19 (B, foldout 11).

b. Output Intermediate Gear (B, foldout 11). This gear 19 is splined to and supports the rear of the drive shaft. When the transmission is manually shifted to forward detent, the smaller diameter (spline) of the output intermediate gear engages the internal splines of output shifter gear 18. When the transmission is manually shifted to reverse detent, the larger diameter of the output intermediate gear meshes with the reverse gear components. The front side of the gear is internally coned to provide a friction surface for a spring-loaded brake cone (described in 2-8, below).

2-8. BRAKE CONE, OUTPUT, REVERSE COMPONENTS

a. Brake Cone (A, foldout 11)

(1) A spring-loaded brake cone 30 is used to prevent gear clash when shifting the transmission from neutral to forward or reverse detent. The cone is fitted to milled flats on the hub of transmission output shaft 28. Compression of spring 29 pushes the cone into contact with the output intermediate gear.

(2) Thus, when the transmission is mechanically shifted, an external, hydraulic-electric system releases the hydraulic clutch. This allows the brake cone to slow the rotation of the output intermediate gear and the drive shaft.

b. Output Components (A, foldout 11)

(1) Output shaft 28 has two splined diameters. The larger diameter engages the inner splines of output shifter gear 18 (B, foldout 11). Transmission output flange 3 (A, foldout 11) splines onto the smaller diameter of output shaft 28. Speedometer and governor drive worm gear 6 is pressed on and keyed to the hub of the output flange.

(2) Shifter fork 15 (B, foldout 11), with three detent notches, moves output shifter gear 18. Shaft 6, keyed to the shifter fork and splined to external shift lever 11, moves the shifter fork in response to movements of the operator's shift control. The shifter fork is accurately positioned for forward, neutral or reverse by a detent ball 13 (B, foldout 10) and spring 15.

(3) When the output shifter gear is in forward drive (shifter fork toward the rear of the transmission), it engages both the output shaft and the output intermediate gear. This provides a direct connection of the drive shaft to the output shaft for vehicle forward operation.

(4) When the shifter fork is at the middle detent, the transmission is in neutral. The transmission is in reverse drive when the shifter fork is moved to the rear detent (the fork toward the output flange). Reverse operation is explained below.

c. Reverse Components (B, foldout 11)

(1) The reverse components consist of two countershafts located below the output shaft: reverse shifter gear assembly 25 and reverse idler gear 24. The reverse shifter gear has an external collar which engages in the shifter fork groove of output shifter gear 18. Therefore, when the shifter fork moves the output shifter gear forward or rearward, the reverse shifter gear moves accordingly.

(2) Teeth on the rear diameter of the reverse shifter gear are in constant mesh with the reverse idler gear. These same teeth mesh with the output intermediate gear only when the reverse shifter gear is toward the front (reverse drive detent) of the transmission.

(3) As described in (2), above, the teeth on the rear diameter of the reverse idler gear

are in constant mesh with the reverse shifter gear. Teeth, on the front of the reverse idler gear, mesh with external teeth of the output shifter gear when the output shifter gear is moved to the front (reverse drive detent) of the transmission.

(4) Refer to paragraph 2-17 for explanation of power flow through the output and reverse components.

2-9. FLUID PUMP

a. Input Pump (A, foldout 14). Input driven oil pump and gear assembly 2 is mounted on the bottom of the transmission and is enclosed by oil pan 28. It is a conventional gear-type pump assembly and is driven by a gear on the input bevel drive gear (VH, VS1 series) or by a gear on the input shaft (VS2 series). Input oil pump idler gear 15 (B, foldout 9 for the VS2 series) or 9 (A, foldout 10 for the VH and VS1 series) is mounted on the input bevel gear bearing retainer. The spring-loaded converter pressure and main-pressure regulator valves are housed in the input-driven oil pump body.

b. Supplies Pressure, Flow. The input-driven oil pump provides oil pressure for hydraulic application of clutches and oil flow for filling the converter, for cooling and for lubrication.

c. Screen at Pump Intake (A, foldout 14). The input-driven oil pump has a close-mesh wire screen 23 attached to the intake section of the pump. The oil screen projects downward into the oil sump, and screens all oil being drawn into the system.

2-10. GOVERNOR

Transmission governor 19 (A, foldout 11) is driven, through shaft and gear assembly 21, by a worm gear on the transmission output flange. Two types of governors have been used on the VH series. One type is a mechanical flyball governor which completes or breaks an electrical circuit to the control valve. This automatically shifts the transmission into hydraulic or direct drive at predetermined road speeds. On later model transmissions, a hydraulic governor is used, which controls fluid pressure as output speed increases or decreases. This pressure shifts the control valves. The VS series uses only the hydraulic governor.

2-11. DRIVE CLUTCH CONTROL VALVE ASSEMBLY

a. Two Types for VH Series (B, foldout 14). Two types of drive clutch control valve assemblies 11 and 29 are used on the VH series, depending on the type of governor. Transmissions, using a mechanical flyball governor, have a control valve with two solenoids to automatically shift from hydraulic to direct drive. Transmissions, using a hydraulic pressure governor, have a control valve with one solenoid, and utilizes governor pressure to shift from hydraulic to direct drive. The internal construction of both valve assemblies are similar, having three spool valves. The neutral solenoid actuates one of these spool valves to engage the hydraulic clutch. A second spool valve is actuated by a solenoid (on two-solenoid valve assemblies) to engage the direct clutch. The second spool valve is actuated by governor pressure, on valve assemblies with one solenoid. In both types of valve assemblies, the third spool valve is actuated by the movement of the second valve to release the hydraulic drive clutch.

b. VS Series. The VS series has a hydraulic governor, therefore, will use a drive clutch control valve assembly with one solenoid. The solenoid actuates one spool valve to engage the hydraulic clutch. Governor pressure actuates the second spool valve to engage the direct drive clutch and the third spool valve is actuated by the movement of the second valve to release the hydraulic drive clutch.

c. Accumulator Valve (B, foldout 14). The drive clutch control valve assembly works in conjunction with a clutch accumulator valve. This is a spring loaded valve 4, located in a bore beneath the drive clutch control valve body mounting surface. The accumulator valve maintains pressure on the hydraulic clutch until sufficient pressure is applied to the direct drive clutch to prevent engine runaway.

2-12. SPLITTER CLUTCH CONTROL VALVE (VS2 series only)

a. Controls Two Input Speeds (foldout 15). The purpose of splitter clutch control valve is to engage one of the two splitter clutches — splitter direct or splitter overdrive. The earlier valve body has a single, spring-loaded spool valve 7, which selects the proper splitter ratio. The control valve on later model transmissions has an additional spool valve (splitter clutch exhaust valve 45), working in conjunction with solenoid 40, which softens the downshift from splitter overdrive to splitter direct drive.

b. Governor Controls Valve Position. On transmissions, with the single spool valve, governor pressure controls the valve. At low governor pressure (low output speed), a spring holds the valve against governor pressure to give direct drive. At a predetermined higher output speed, a higher governor pressure will move the valve against spring pressure, allowing main pressure to engage the splitter overdrive clutch. Later model transmissions have the same valve action, as described, but also have a second spool valve, the splitter clutch exhaust valve. This valve is controlled by the action of a solenoid and needle valve, assembled on the valve body. At predetermined speeds, above idle, the solenoid (connected to a switch on the throttle of the engine) is de-energized, closing the spring-loaded needle valve. Main pressure, retained by the closed needle valve, moves the splitter exhaust valve against its spring. This opens a channel to exhaust the splitter overdrive clutch into the lubrication circuit when the transmission is downshifting from splitter overdrive to splitter direct. At a predetermined throttle setting, when the vehicle is decelerating, the solenoid is energized, opening the needle valve. Main pressure is then exhausted from the bore of the valve, and the spring moves the valve. The channel exhausting the splitter overdrive clutch, is now directed through an orifice to the lubrication circuit. This delays momentarily the release of the splitter overdrive clutch, which permits a smoother downshift, from splitter overdrive to splitter direct drive.

2-13. OIL FILTERS, COOLER

a. Not Supplied with Transmission.

While these components are not supplied by the transmission manufacturer, they are necessary for proper transmission operation. The VH and VS series have an oil filter in the main-pressure circuit. The VS series has an additional oil filter (optional on VH series) in the converter-in circuit. All models require an external-mounted oil cooler between the converter-out and converter-in circuits.

b. Externally Mounted. Oil filters and coolers are mounted external of the transmission. All hydraulic connections between these components and the transmission or vehicle are by hoses or tubes.

2-14. HYDRAULIC SYSTEM (VH series with hydraulic governor) (foldout 3 and 4)

Note: Foldouts 3 and 4 differ only in the shift control valve and neutral switch circuit (refer to a(4), below). System is illustrated in neutral.

a. Main-Pressure Circuit

(1) Oil is drawn from the sump, through a screen, by the input-driven oil pump and is directed to four points: the main-pressure regulator valve, through the oil filter to the governor, to the hydraulic drive clutch exhaust valve, and to the direct drive clutch control valve.

(2) At the main-pressure regulator valve (located in the oil pump), oil pressure raises a spring-loaded valve, thereby allowing oil to flow into the lubrication and converter-in circuits. When the oil flow in these two circuits is such that main pressure balances the pressure of the main-pressure regulator valve spring, main pressure is established.

(3) Governor pressure is lower than main pressure. Its value depends upon the rotational speed of the governor.

(4) On earlier models (foldout 3) the operator's shift lever arrangement is designed so that, in neutral detent, the neutral switch is closed, energizing the neutral solenoid. The hydraulic drive clutch valve is moved upward, by the energized solenoid, thus main pressure is blocked by the valve. On later models (foldout 4) the shift mechanism is designed so that the neutral switch is open during neutral operation. Also, the valve body is designed so the action of the solenoid and hydraulic drive clutch valve is modified from that described above. When the switch is open, the solenoid is not energized, thus main pressure is blocked at the valve and the clutch is released. These transmissions will have the hydraulic drive clutch engaged when the neutral switch is closed. Closing of the switch energizes the solenoid. The hydraulic drive clutch valve is moved upward, allowing main pressure to engage the clutch.

(5) At the direct drive clutch control valve, main pressure is blocked until the valve is moved. Then pressure will be directed to the direct drive clutch.

b. Converter-in-Circuit. The converter pressure regulator valve, located in the input-driven oil pump, regulates converter-in pressure by relieving oil to the sump. Converter-in flow passes through a check valve, which prevents back flow, and continues to the inlet side of the torque converter. This circuit keeps the torque converter continuously filled with oil.

c. Lubrication Circuit

(1) The lubrication circuit is derived from the converter-in circuit. However, the lubrication pressure is somewhat lower than the converter-in pressure due to the restriction of flow caused by the orifices in the lubrication circuit.

(2) An additional source of lubrication is derived from the converter-in circuit, through a check valve in the center of the drive shaft. The oil is distributed to various points along the length of the shaft by a passage in the center of the shaft.

d. Converter Internal Circuit. Oil flow within the torque converter is caused by the rotation of the torque converter pump. The converter pump rotates only when the hydraulic drive clutch is engaged. The oil flow is from the converter pump, through the turbine first-stage vanes, through the stator vanes, through the turbine second-stage vanes and back to the pump.

e. Converter-out and Cooler Oil Circuit

(1) In converter operation (torque converter pump rotating), heat is generated by the turbulence within the converter. The rotating converter elements create a pumping action (auto flow), which causes the oil to flow out of the converter, through the oil cooler (heat exchanger) and back into the converter. The circulation of the oil through the cooler removes the heat from the oil.

(2) When the transmission is shifted into direct drive, converter pump action stops and the circulation of oil is dependent upon the input oil pump. The oil from the input pump flows directly into the oil cooler and can leave through either end of the cooler, flowing into the converter and out through the lubrication port in the center of the input shaft. This permits cooler oil flow in direct drive.

(3) On earlier models the converter-in line is attached directly to the cooler line leading into the converter, bypassing the oil cooler. In this system an alternate cooler was required when it was necessary to operate for long periods in direct drive. For a more efficient cooling system, we recommend the circuit flow conform to item (2), above.

(4) At the converter-out line, an air-bleed orifice maintains a continuous small return flow of oil to the oil sump. This bleeds off any air which might accumulate and cause cavitation in the converter.

f. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldouts 3 and 4 and is explained in a through e, above.

g. Forward, Hydraulic Drive Operation — Hydraulic Action

(1) The hydraulic drive clutch is engaged when the shift lever is moved out of

neutral to forward detent. This results from the opening or closing of the neutral switch (see a(4), above).

(2) Moving the shift lever from neutral to forward detent also mechanically moves the output shifter gear from N to F (foldout 3 or 4). The transmission is now in forward mode.

h. Forward, Direct Drive Operation — Hydraulic Action (foldouts 3 and 4)

(1) After starting in forward, as described in g above, and when the vehicle speed reaches a predetermined point, automatic shift to direct drive occurs. Governor pressure, which increases as transmission output speed increases, moves the direct drive clutch control valve upward against its spring. In the upward position, the valve directs main pressure through an orifice to the direct drive clutch circuit, also to the clutch accumulator valve, and to the hydraulic drive clutch exhaust valve.

(2) Main pressure engages the direct drive clutch at a reduced pressure due to the oil flowing into the accumulator valve. The accumulator valve is moved leftward by the oil. As long as the valve is moving, a reduced pressure is applying the clutch. Before the accumulator valve bottoms in its bore, main pressure in this circuit moves the hydraulic drive exhaust valve upward. This exhausts the hydraulic drive clutch. When the accumulator valve bottoms (leftward), full-main pressure engages the direct drive clutch.

(3) In direct drive, the drive shaft is connected directly to the bevel gear and the torque converter pump element is no longer driven. The over-running clutch disengages, which leaves the torque converter inactive.

i. Reverse — Hydraulic Action

(1) When the shift lever is moved to the reverse detent, the output shifter gear is moved to R (foldout 3 and 4). This converts the rotation of the drive shaft to a reverse rotation of the output shaft.

(2) The hydraulic action is the same as forward, hydraulic drive, as described in g(1), above. Normally, only hydraulic drive operation is utilized in reverse due to the lower vehicle speeds used in this mode. However, sufficient reverse speed will cause the shift to direct drive described in h, above.

2-15. HYDRAULIC SYSTEM
(VH series with electric governor)
(foldout 5)

Note: System is illustrated in neutral.

a. Similar to VH with Hydraulic Governor. This hydraulic system is essentially the same as previously explained for transmissions with hydraulic governor. The drive control valve has an additional direct drive solenoid, plus some minor lubrication and electrical circuit changes in the transmission.

b. Main-Pressure Circuit. The main-pressure circuit functions are the same as described in paragraph 2-14a, above, except that main pressure is not directed to the governor.

c. Converter-in Circuit, Lubrication Circuit, Converter Internal Circuit, Converter-out and Cooler Oil Circuit. These circuits function in the same manner as those described in paragraphs 2-14b, c, d and e.

d. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldout 5.

e. Forward, Hydraulic Drive Operation — Hydraulic Action. Operation of the transmission in this condition is the same as described in paragraph 2-14g, above.

f. Forward, Direct Drive Operation — Hydraulic Action. Operation of the shift to direct drive is the same as described in paragraph 2-14h, above, except for governor action. The governor speed increases with the output speed of the transmission. At a predetermined speed, a switch located in the governor closes, which energizes the direct drive solenoid. This moves the direct drive clutch control valve in its bore, and allows main pressure to flow into the direct drive clutch circuit.

g. Reverse — Hydraulic Action. The hydraulic action in reverse is the same as described in paragraph 2-14i, above.

2-16. HYDRAULIC SYSTEM (VS1 series, foldout 8)

Note: Foldout 8 illustrates the hydraulic circuit of the VS1-8 model with a hydraulic governor. This circuit is very similar in function to the VH series, differing only in the addition of an oil filter in the converter-in circuit, which coordinates with the oil filter in the main-pressure circuit to cleanse the system of foreign material.

a. Main-Pressure Circuit

(1) Oil is drawn from the sump, through a screen, by the input-driven oil pump and is directed to four points; the main pressure regulator valve, through the oil filter to the governor, through the hydraulic drive clutch exhaust valve cavity and to the direct drive clutch and hydraulic drive clutch control valves at which two points it is blocked.

(2) At the main-pressure regulator valve (located in the oil pump), oil pressure raises a spring-loaded valve, thereby allowing oil to flow into the lubrication and converter-in circuits. When the oil flow in these two circuits is such that main pressure balances the pressure of the main-pressure regulator valve spring, main pressure is established.

(3) The decrease or increase of the governor pressure is controlled by transmission output speed. However, governor pressure cannot become greater than main pressure.

(4) The operator's shift lever arrangement is designed so that in neutral detent the neutral switch remains open. Moving the shift lever to forward position closes the neutral switch, energizing the solenoid. This forces the hydraulic drive clutch valve to move upward, thus releasing main pressure to engage the hydraulic clutch.

b. Converter-in Circuit. The converter pressure regulator valve, located in the input-driven oil pump, regulates converter-in pressure by bypassing overage oil to the sump. Converter-in flow passes through a check valve, which prevents drain back at shutdown and then through an oil filter and the oil cooler to the inlet side of the torque converter. This circuit keeps the torque converter continuously filled with oil.

c. Lubrication Circuit

(1) The lubrication circuit cascades from the converter-in circuit. Therefore, the lubrication pressure is always lower than the converter-in pressure.

(2) An additional source of lubrication enters through a check valve in the center of the drive shaft. The oil is distributed to various points via the hollow shaft.

d. Converter Internal Circuit. Oil flow within the torque converter is caused by the rotation of the torque converter pump. The converter pump rotates only when the hydraulic drive clutch is engaged. The oil flow is from the converter pump, through the turbine first-stage vanes, through the stator vanes, through the turbine second-stage vanes and back to the pump.

e. Converter-out and Cooler Oil Circuit

(1) In converter operation the rotating converter elements create a pumping action (auto-flow), which causes the oil to flow out of the converter, through the oil cooler (heat exchanger) and back into the converter. The circulation of the oil through the cooler removes the heat from the oil.

(2) When the transmission is shifted into direct drive, converter pump action stops and the circulation of oil is dependent upon the input oil pump. The oil flowing into the oil cooler can leave through either end of the cooler and flow into the converter, and flow out through the lubrication port in the center of the input shaft.

(3) At the converter-out line, an air-bleed orifice maintains a continuous small return flow of oil to the oil sump. This bleeds off any air which might aerate the converter.

f. Neutral-Hydraulic Action. The action of the hydraulic system during neutral, engine running, is illustrated in foldout 8 and is explained in a, through e., above.

g. Forward, Hydraulic Drive Operation — Hydraulic Action

(1) The hydraulic drive clutch is engaged when the shift lever is moved out of neutral to forward detent. This results from the closing of the neutral switch. (Refer to a. 4, above.)

(2) Moving the shift lever from neutral to forward detent also mechanically moves the output shifter gear from (N) neutral to (F) forward (foldout 8). The transmission is now in forward mode.

h. Forward, Direct Drive Operation — Hydraulic Action (foldout 8)

(1) After starting in forward, as described in g. above, and when the transmission output speed reaches 1300 RPM, automatic shift to direct drive occurs. Governor pressure, which increases as transmission output speed increases, moves the direct drive clutch control valve upward against its spring. In the upward position, the valve directs main pressure through an orifice to the direct drive clutch circuit, also to the clutch accumulator valve, and to the hydraulic drive clutch exhaust valve.

(2) Main pressure engages the direct drive clutch at a reduced pressure due to the oil flowing into the accumulator valve. The accumulator valve is moved leftward by the oil. As long as the valve is moving, a reduced pressure is applying the clutch. Before the accumulator valve bottoms in its bore, main pressure in this circuit moves the hydraulic drive exhaust valve upward. This exhausts the hydraulic drive clutch. When the accumulator valve bottoms (leftward), full main pressure engages the direct drive clutch.

(3) In direct drive, the drive shaft is connected directly to the bevel gear and the torque converter pump element is no longer driven. The over-running clutch disengages, which leaves the torque converter inactive.

i. Reverse — Hydraulic Action

(1) When the shift lever is moved to the reverse detent, the output shifter gear is moved to R (foldout 8). This converts the rotation of the drive shaft to a reverse rotation of the drive shaft to a reverse rotation of the output shaft.

(2) The hydraulic action is the same as forward, hydraulic drive, as described in g. (1), above. Normally, only hydraulic drive operation is utilized in reverse due to the lower vehicle speeds used in this mode. However, sufficient reverse speed will cause the shift to direct drive described in h., above.

2-17. HYDRAULIC SYSTEM (VS2 series) (foldouts 6 and 7)

Note: Foldouts 6 and 7 differ only in the shift control valve and neutral switch (refer to para 2-14a(4), above). System is illustrated in neutral.

a. Similar to VH Series. The VS2 series hydraulic system is essentially the same as the VH series. The differences, in the VS2 series, are an oil filter in the converter-in circuit, a splitter clutch control valve and some lubrication circuit changes. Refer to paragraph 2-14a through e, above, for explanation of the VH series. The differences are outlined in b through d, below.

b. Oil Filter. The VS2 series has an oil filter in the converter-in circuit, in addition to the oil filter in the main-pressure circuit.

c. Splitter Clutch Control Valve. The VS2 series has two splitter clutches, not included on the VH series. Therefore an additional valve assembly is required to control these clutches. The splitter clutch control valve assembly contains a spring-loaded, spool-type valve which moves lengthwise in its bore. Spring pressure holds the valve leftward. This blocks main pressure, but does allow the lubrication circuit to keep the splitter overdrive clutch circuit filled with oil, although the clutch is not engaged. Governor pressure acts upon the left end of the valve, and when governor pressure is sufficiently high, moves the valve rightward against spring pressure. Later model transmissions (foldout 7) have an additional spool valve (splitter exhaust valve) to soften the downshift as described in paragraph 2-12b, above.

d. Lubrication Circuit. The inclusion of splitter clutches in the VS2 series necessitates differences in the lubrication system to serve the clutches.

e. Neutral — Hydraulic Action. The action of the hydraulic system during neutral, engine running, is as illustrated in foldouts 6 and 7, and as described previously.

f. Forward, Splitter Direct, Hydraulic Drive Operation — Hydraulic Action

(1) Operation of the VS2 series in this condition is essentially the same as the operation of the VH series, described in paragraph 2-14g, above. The splitter direct drive clutch is engaged, causing the bevel drive gear to rotate at engine speed — the same as in the VH series.

(2) The hydraulic action is the same as that in the VH series.

g. Forward, Splitter Direct, Direct Drive Operation — Hydraulic Action. The automatic shift to direct drive operation occurs the same as described for the VH series in paragraph 2-14h, above.

h. Forward, Splitter Overdrive Operation — Hydraulic Action

(1) This drive range is made possible by the input splitter planetary and clutches. The VH series does not have this design feature.

(2) The spring in the splitter clutch control valve is calibrated to oppose a greater governor pressure than is the spring in the direct drive clutch valve. Therefore, the splitter clutch control valve remains leftward (direct drive splitter clutch engaged) until the governor produces a higher pressure than was required to shift the transmission to direct drive (from hydraulic drive). Thus, when the transmission output reaches sufficient speed, governor pressure moves the splitter clutch control valve to the right. In this position, the valve directs main pressure to the splitter clutch piston, moving it rightward. Moving the piston to the right lifts the Belleville spring off the splitter direct drive clutch and forces it against the apply plate of the splitter overdrive clutch, engaging the clutch.

(3) The splitter overdrive clutch, when engaged, stops the entire clutch housing and input planetary sun gear. The planetary carrier, driven by the engine flywheel, then overdrives the planetary ring gear attached to the transmission input shaft.

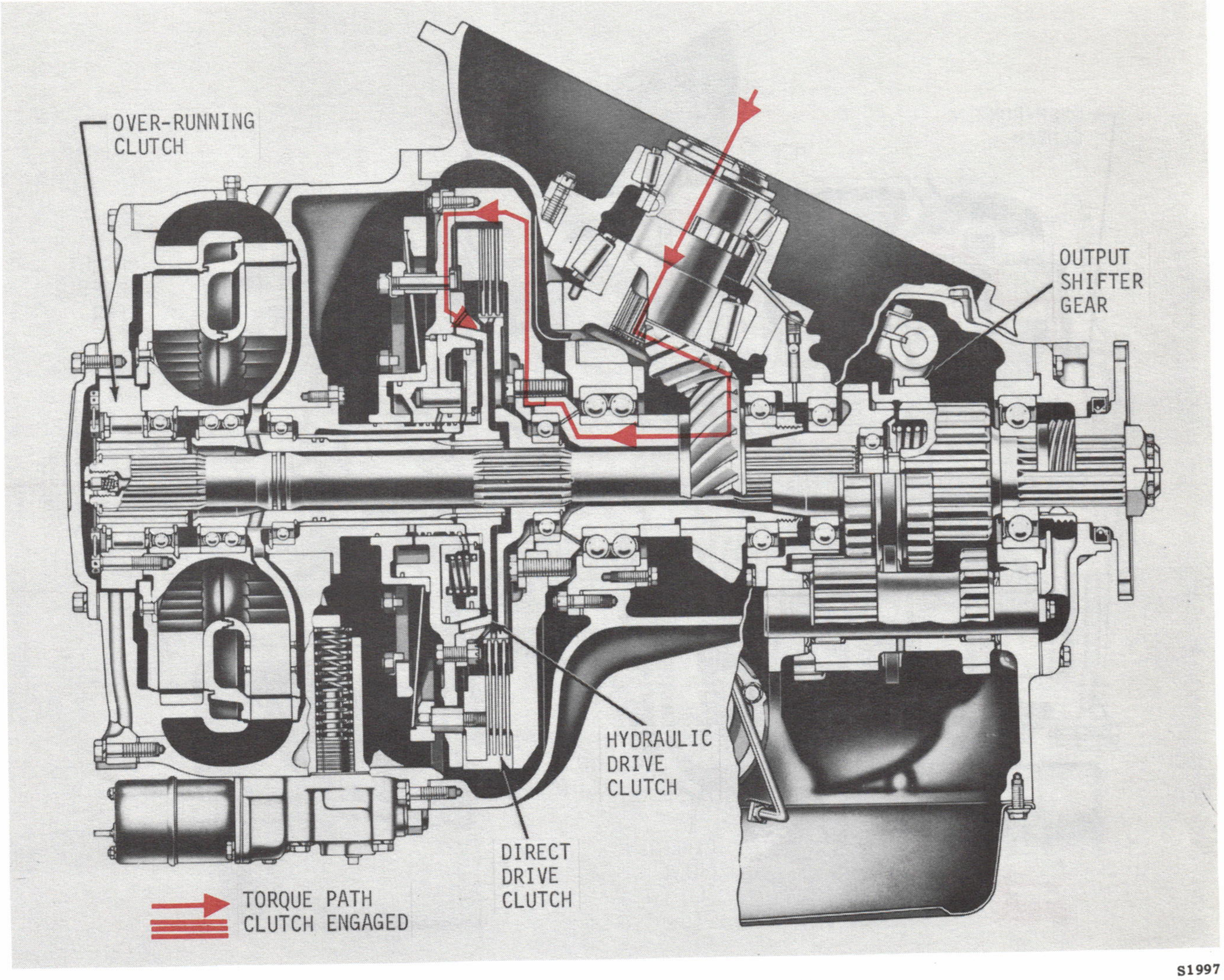

Fig. 2-1. VH Series, neutral—torque path

i. Reverse — Hydraulic Action. Hydraulic action in reverse for the VS2 series is the same as described for the VH series in paragraph 2-14i, above.

2-18. TORQUE PATHS

Note: The torque paths for the VH and VS series transmissions are illustrated in figures 2-1 through 2-13. In all the illustrations, the output shifter gear is shown in the forward drive position (moved to the left). In actual operating conditions, this gear is moved to accomplish the various drive ranges, as explained below.

a. VH Series, Neutral — Torque Path (fig. 2-1)

(1) In neutral, as in all drive ranges, the engine drives the bevel drive gear through a splined shaft. The bevel driven gear, driven by the drive gear, is keyed to and drives a sleeve which is bolted to the drive clutch plate assembly. A cover assembly is bolted to the drive clutch plate assembly. The drive clutch plate assembly and the cover assembly enclose the drive clutches.

(2) The drive clutches are released in neutral, thus torque is not transmitted beyond the clutch.

(3) The output shifter gear is in the neutral (middle) position, and is out of mesh with the output intermediate gear.

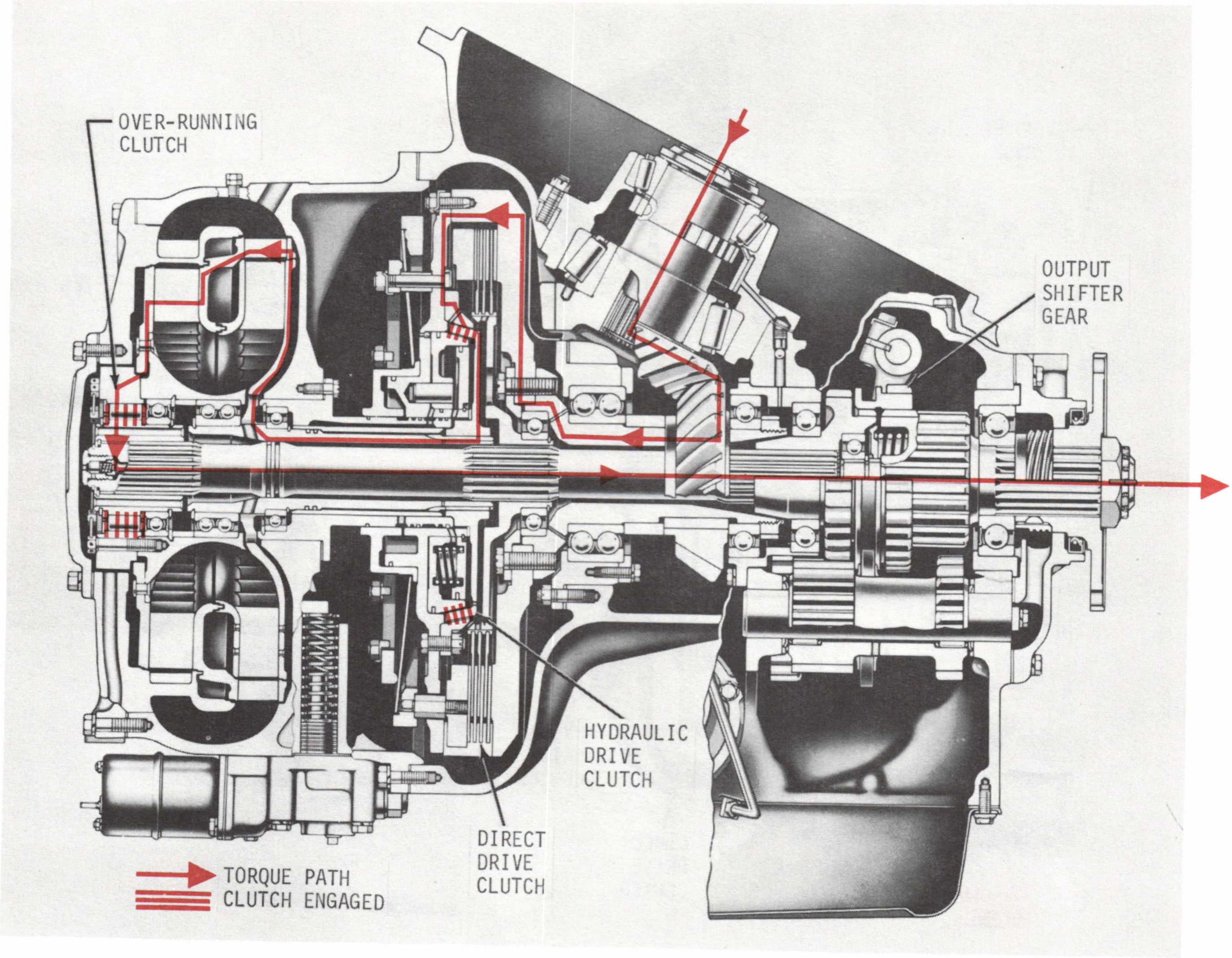

Fig. 2-2. VH Series, forward, hydraulic drive—torque path

b. VH Series, Forward, Hydraulic Drive — Torque Path (fig. 2-2)

(1) The hydraulic drive clutch is engaged when the shift control is moved to the forward (F) position.

(2) When the hydraulic drive clutch is engaged, torque is transmitted mechanically from the engine to the torque converter pump. The torque converter pump rotates and forces oil against the vanes of the torque converter turbine, causing the turbine to rotate. Torque is transmitted hydraulically through the turbine, to the over-running clutch, to the drive shaft and output intermediate gear.

(3) In forward, the output shifter gear is moved to the left and in mesh with the output intermediate gear. The output shifter gear is also splined to the output shaft, therefore the output shaft will rotate with the output intermediate gear.

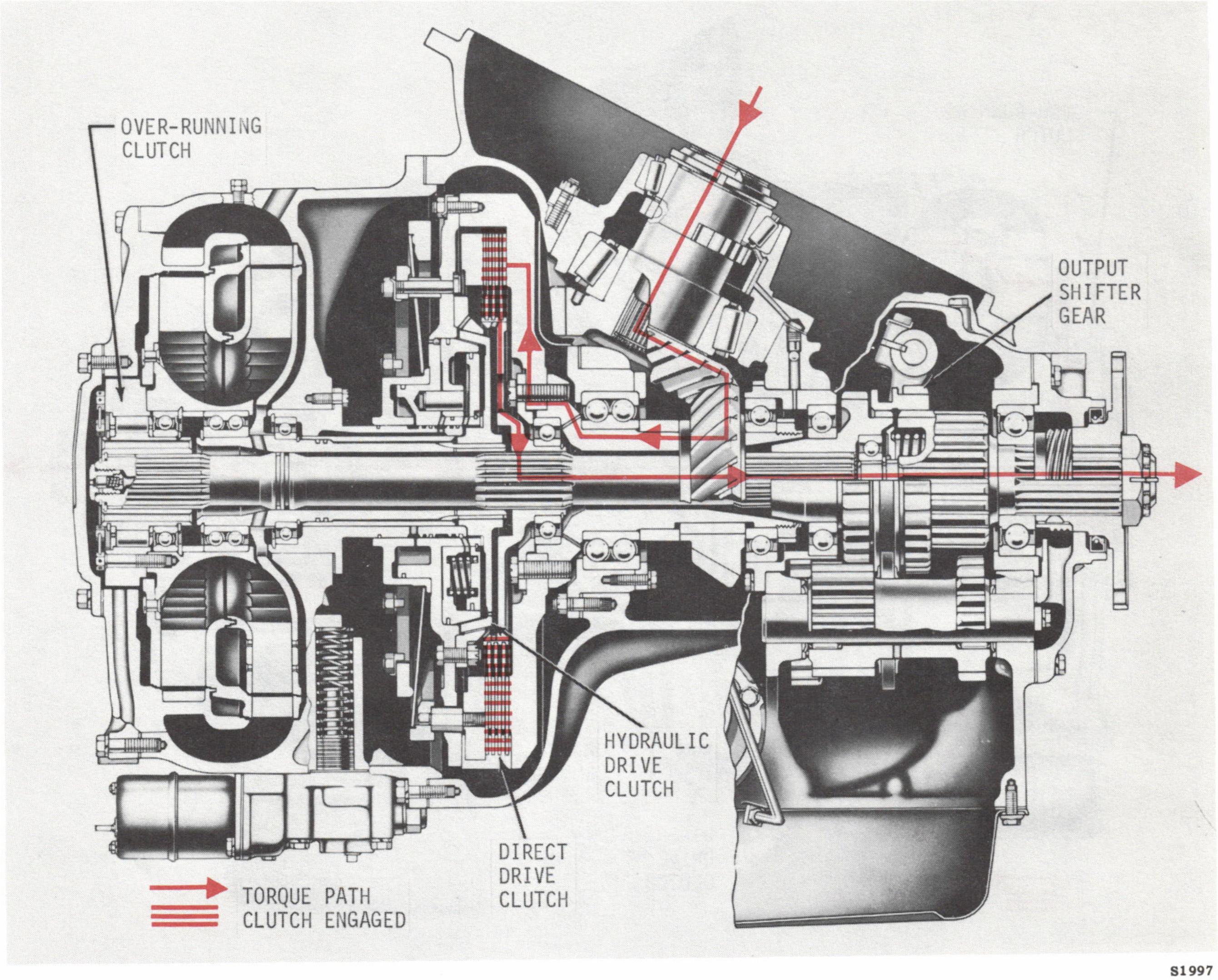

Fig. 2-3. VH Series, forward, direct drive—torque path

c. VH Series, Forward, Direct Drive — Torque Path (fig. 2-3)

(1) The direct drive clutch is engaged and the hydraulic drive clutch is released. Torque is transmitted from the engine to the drive clutches as described previously.

(2) The direct drive clutch hub is splined to, and drives, the drive shaft. Therefore, torque is transmitted from the direct drive clutch to the drive shaft and output intermediate gear, bypassing the torque converter. Rotation of the drive shaft releases the overrunning clutch and causes the drive shaft to rotate independently of the converter turbine.

(3) When the shift lever is moved to forward (F) detent, the output shifter gear is moved to the left and in mesh with the output intermediate gear. The output shifter gear is also splined to the output shaft, therefore the output shaft will rotate with the output intermediate gear.

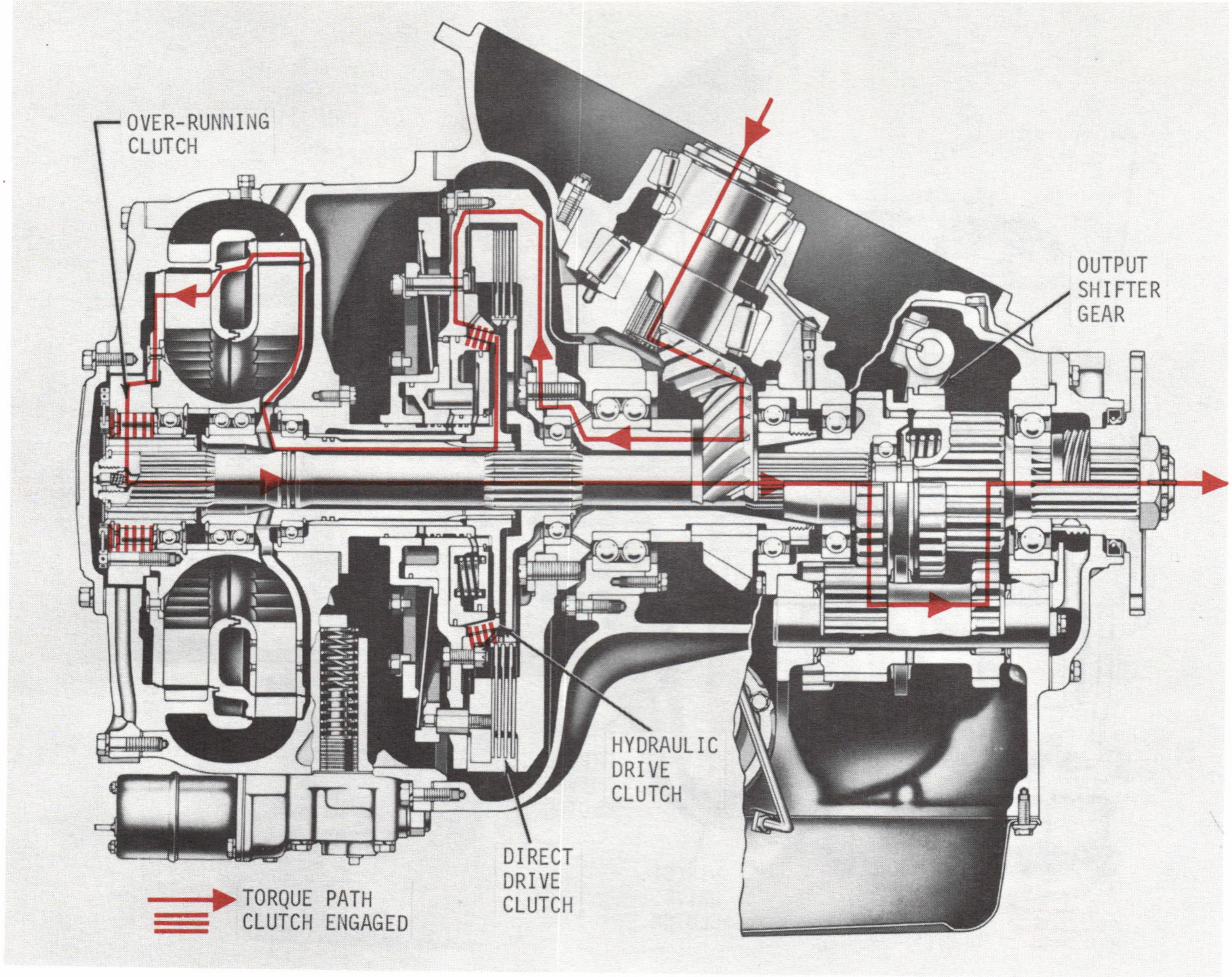

Fig. 2-4. VH Series, reverse—torque path

d. VH Series, Reverse — Torque Path (fig. 2-4)

(1) The torque path from the engine to the output intermediate gear is the same as described previously for forward.

(2) The reverse shifter gear has an external collar which engages in the shifter fork groove of the output shifter gear. In reverse, the output shifter gear is moved to the right and into mesh with the reverse idler gear. Also moving lengthwise to the right with the output shifter gear is the reverse shifter gear. In the rightward position, the reverse shifter gear is in mesh with the output intermediate gear as well as being in constant mesh with the reverse idler gear.

(3) Thus, in reverse, the output intermediate gear drives the reverse shifter gear; the reverse shifter gear drives the reverse idler gear; the reverse idler gear drives the output shifter gear. The output shifter gear is splined to the output shaft and is driven in a direction opposite that of the output intermediate gear.

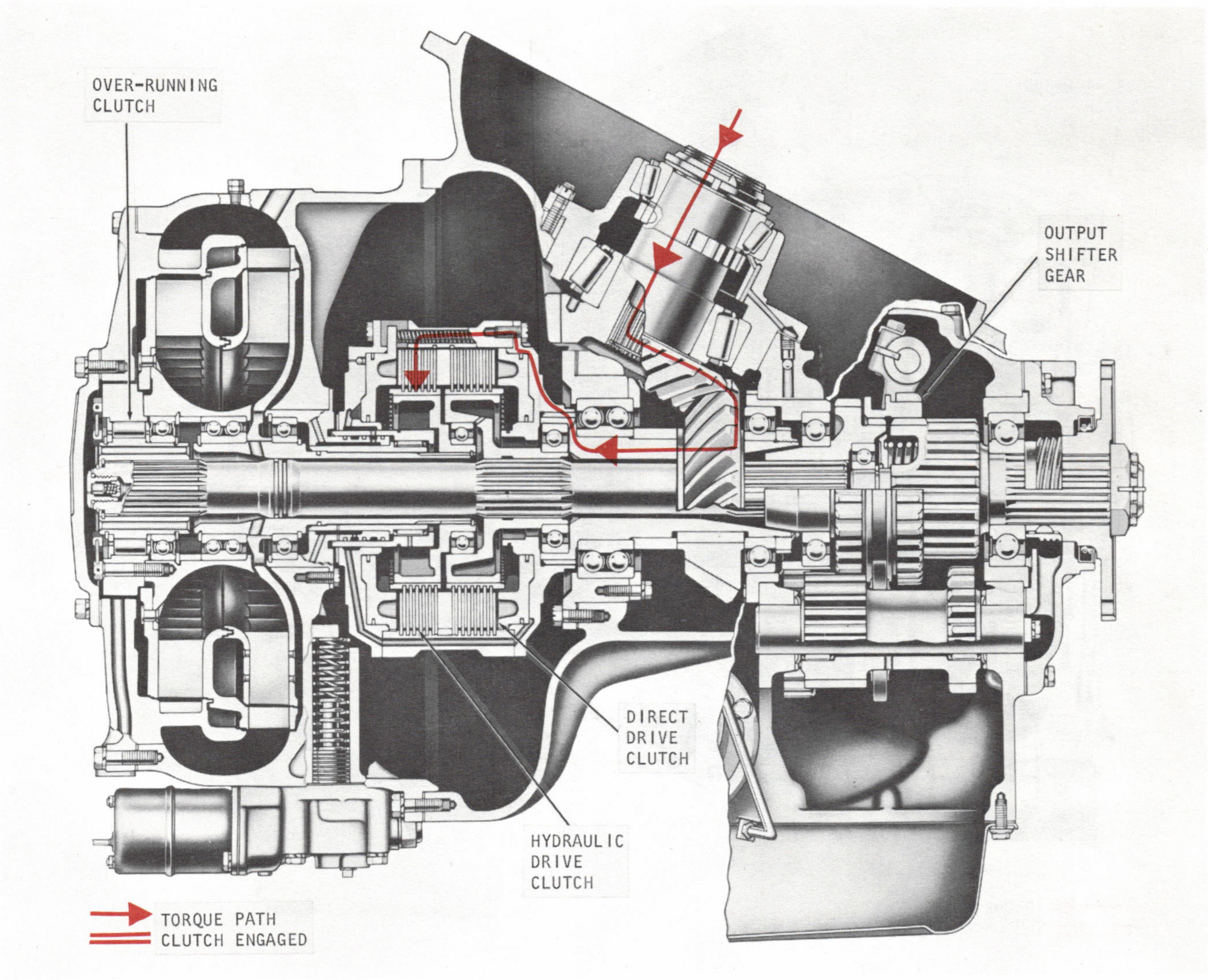

Fig. 2-5 VS1 Series, neutral-torque path

e. VS1 Series, Neutral — Torque Path (fig. 2-5)

(1) In neutral, as in all drive ranges, the engine drives the bevel drive gear through a splined shaft. The bevel driven gear is in mesh with the drive gear and is keyed to a sleeve which is attached to the drive clutch cover and drum.

(2) The drive clutches are not engaged in neutral, thus torque is not transmitted through either clutch.

(3) The output shifter gear is in the neutral (middle) position, and is out of mesh with the output intermediate gear.

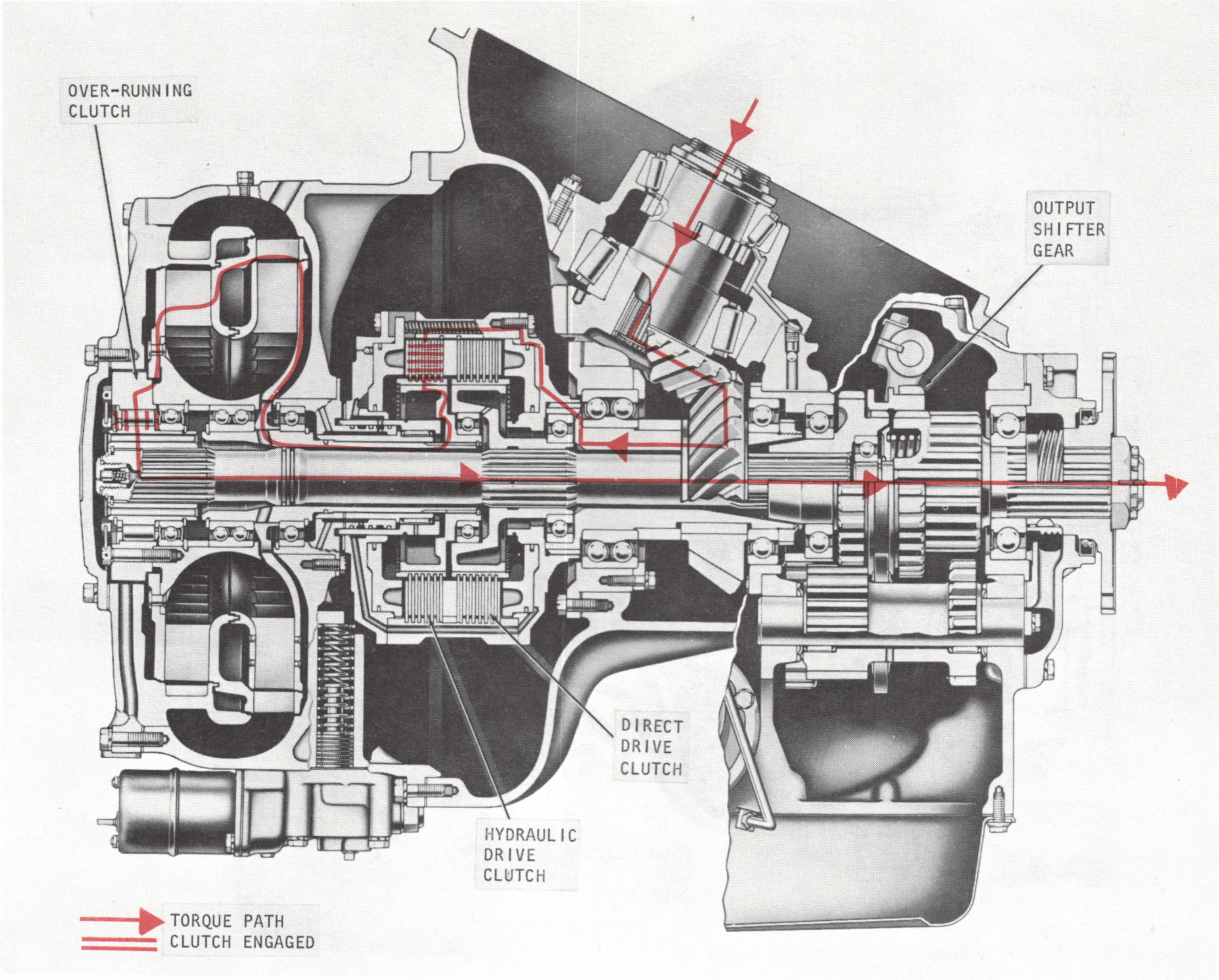

Fig. 2-6 VS1 Series, forward, hydraulic drive—torque path

f. VS1 Series, Forward, Hydraulic Drive — Torque Path (fig. 2-6)

(1) Torque is transmitted from the engine to the drive clutch drum as described previously. The hydraulic drive clutch is engaged when the shift lever is moved to the forward (F) position.

(2) The engaged hydraulic drive clutch rotates the torque converter pump. The pump hydraulically drives the turbine, over-running clutch, drive shaft and output intermediate gear, as explained in b. (2), above.

(3) The remainder of the torque path is explained in b. (3), above.

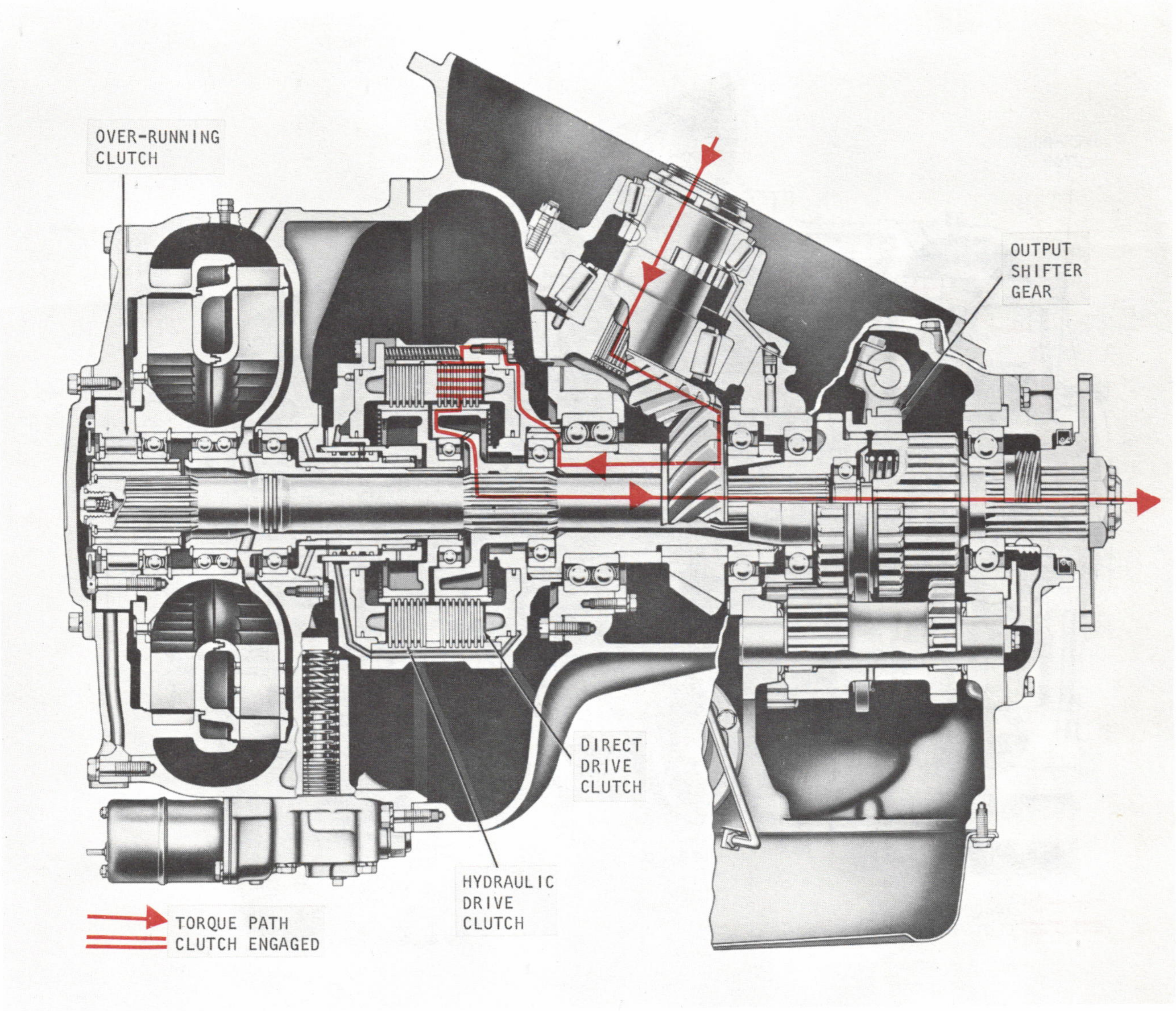

Fig. 2-7 VS1 Series, forward, direct drive—torque path

g. VS1 Series, Forward, Direct Drive — Torque Path (fig. 2-7). The torque path for this operational mode is the same as described in c, above.

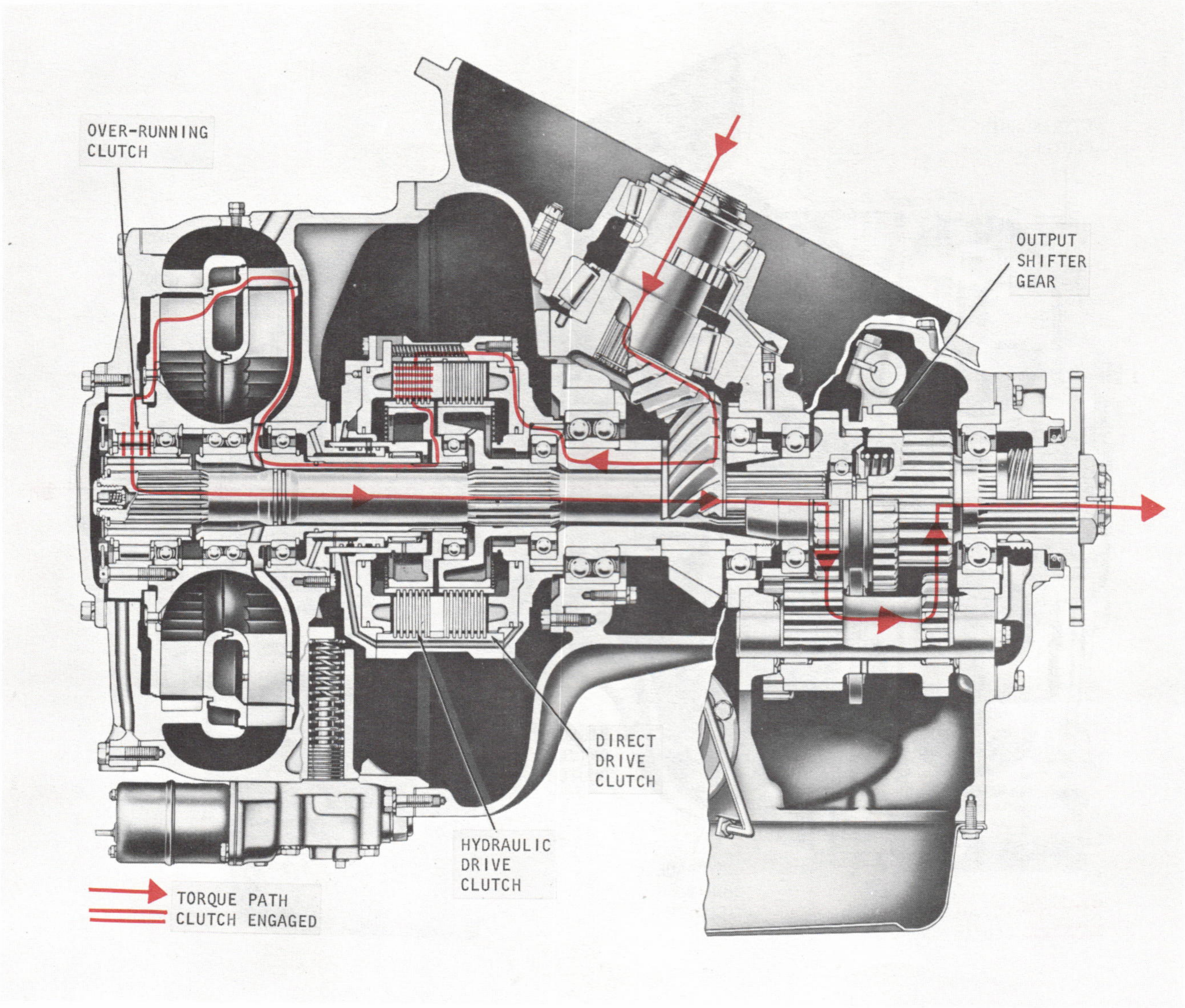

Fig. 2-8 VS1 Series, reverse—torque path

h. VS1 Series, Reverse — Torque Path (fig. 2-8). The torque path for reverse mode is the same as described for the VH series in d, above.

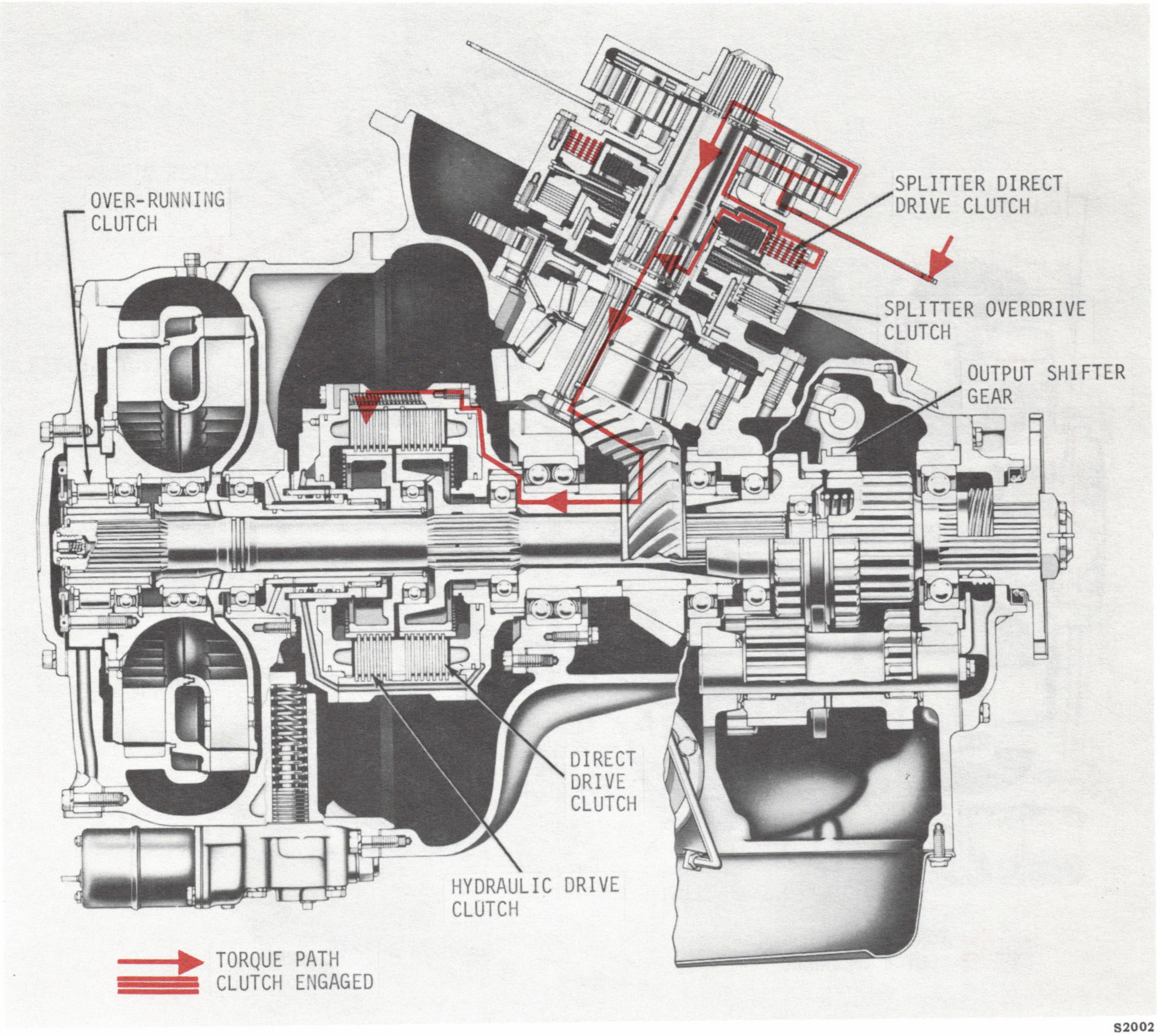

Fig. 2-9 VS2 Series, neutral—torque path

i. VS2 Series, Neutral — Torque Path (fig. 2-9)

(1) Torque is transmitted from the engine to the bevel drive gear by a splitter arrangement consisting of two clutches and a planetary gear set. In neutral, the splitter direct drive clutch is engaged, locking the input shaft and splitter clutch drum together. The splitter planetary ring gear is splined to the input shaft. The splitter planetary sun gear is attached to the clutch drum. Thus, when these two elements are locked together, and driven by the splitter planetary carrier, there is no relative rotational gear action. Since the splitter planetary carrier is attached to the engine flywheel by a drive plate, the drive from the engine to the bevel drive gear is direct (no speed change).

(2) The bevel driven gear is in mesh with the drive gear and is keyed to a sleeve which is attached to the drive clutch cover and drum.

(3) The drive clutches are not engaged in neutral, thus torque is not transmitted through either clutch.

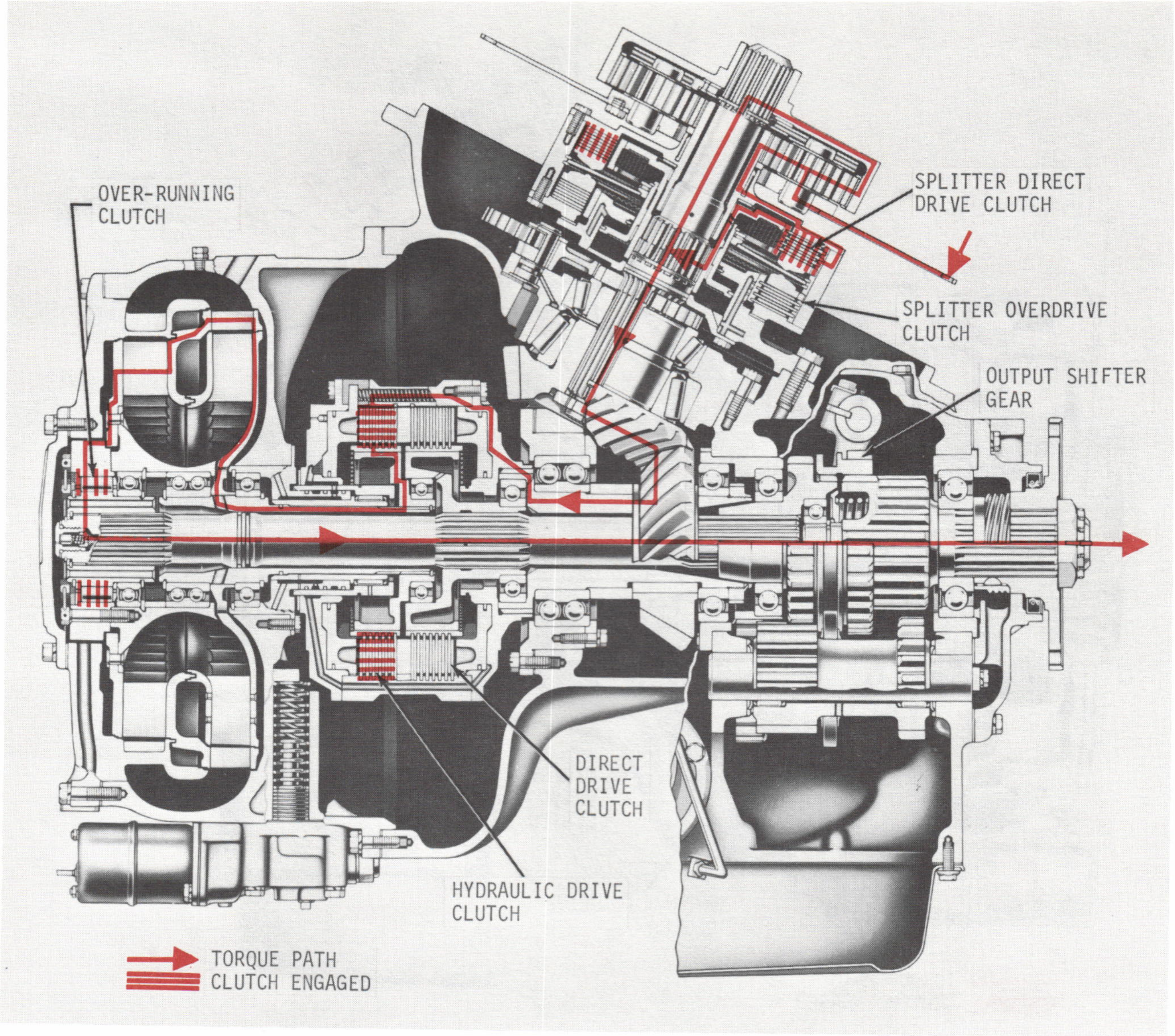

Fig. 2-10 VS2 Series, forward, hydraulic drive, first gear—torque path

j. VS2 Series, Forward, Hydraulic Drive, First Gear — Torque Path (fig. 2-10)

(1) Torque is transmitted from the engine to the drive clutch drum as described previously. The hydraulic drive clutch is engaged when the shift lever is moved to the forward (F) position.

(2) The engaged hydraulic drive clutch rotates the torque converter pump. The pump hydraulically drives the turbine, over-running clutch, drive shaft and output intermediate gear, as explained in b(2), above.

(3) The remainder of the torque path is explained in b(3), above.

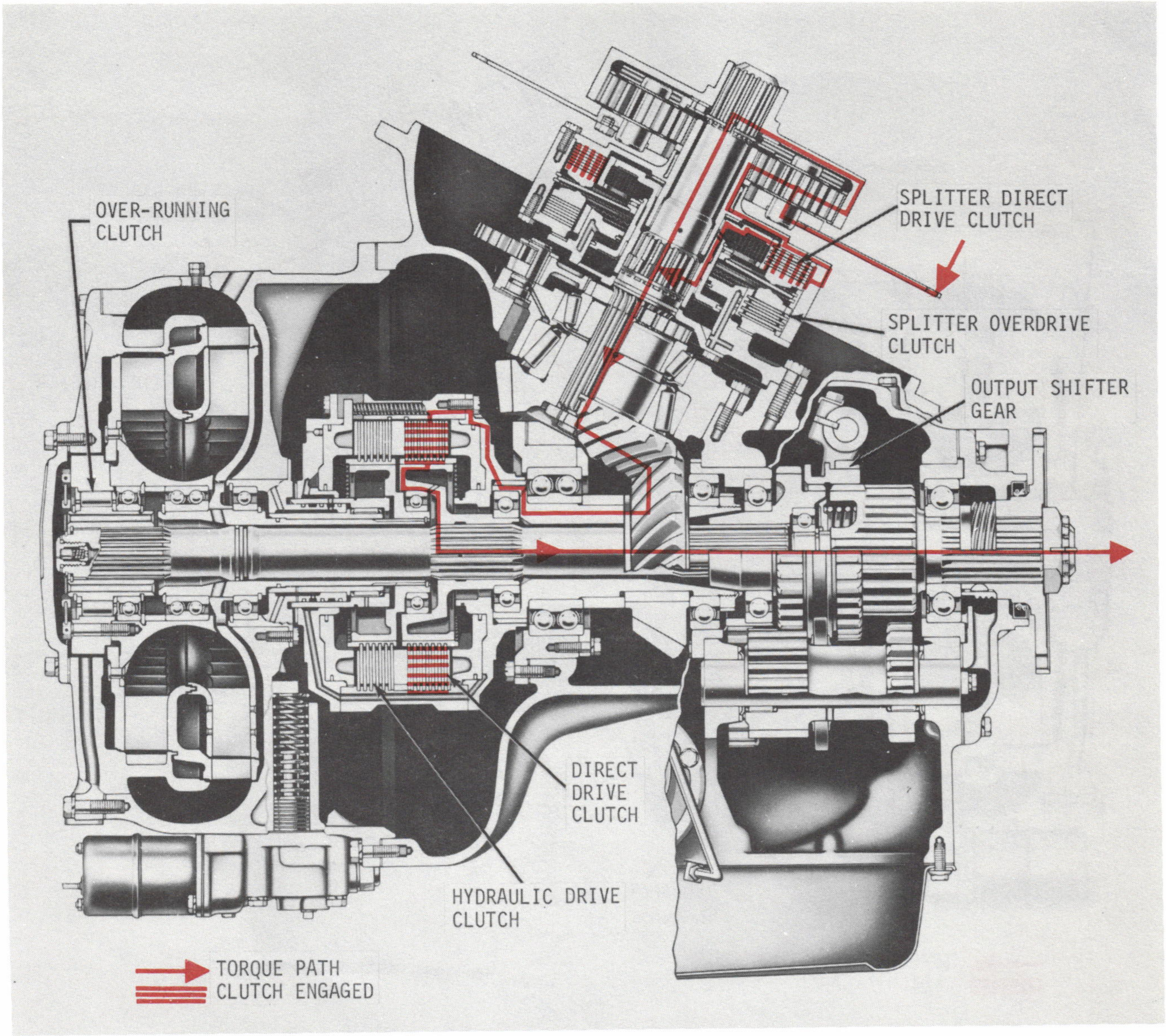

Fig. 2-11 VS2 Series, forward, direct drive, first gear—torque path

k. VS2 Series, Forward, Direct Drive, First Gear — Torque Path (fig. 2-11). The torque path for this operational mode is the same as described in c, above.

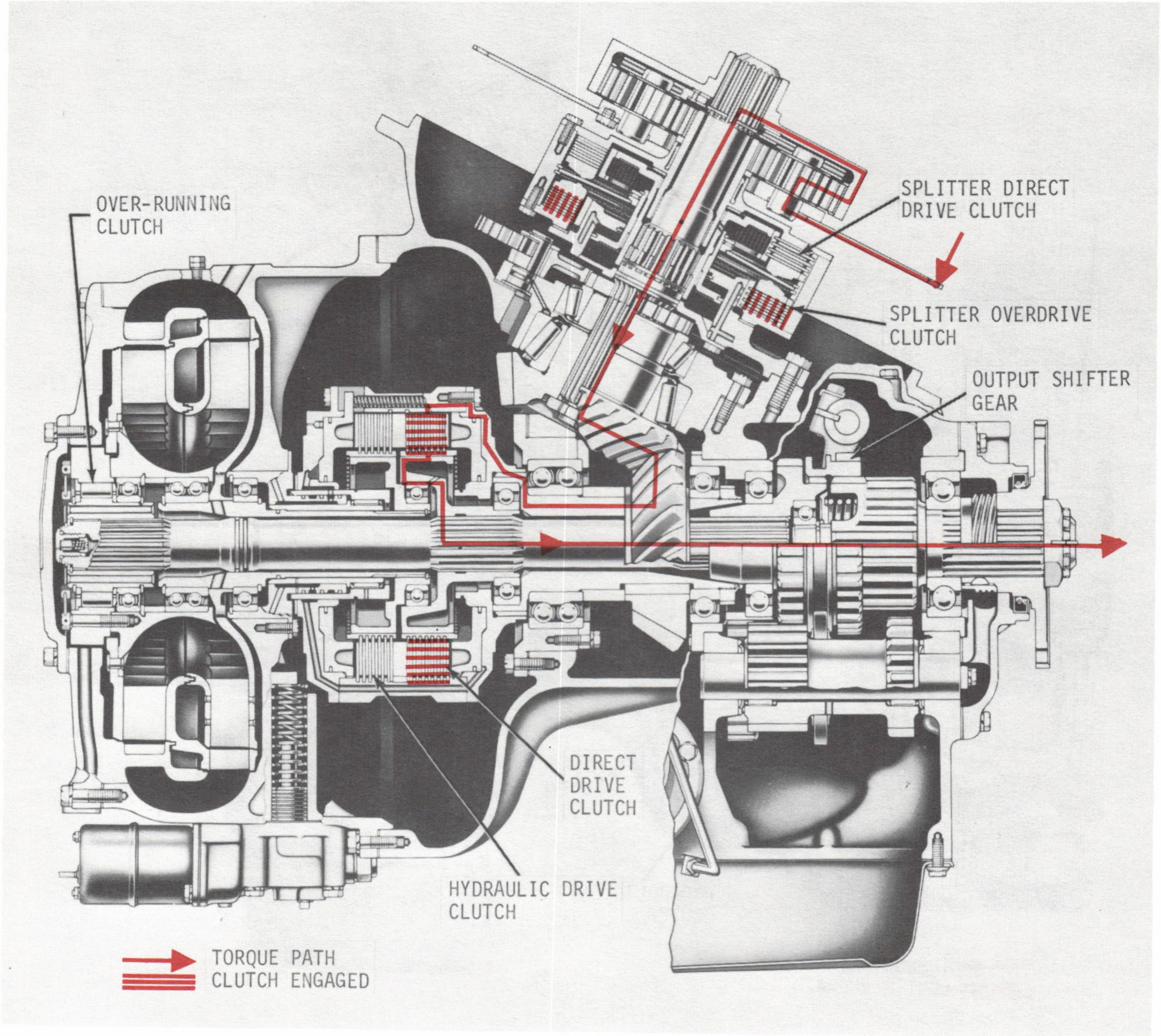

Fig. 2-12 VS2 Series, forward, direct drive, second gear—torque path

l. VS2 Series, Forward, Direct Drive, Second Gear – Torque Path (fig. 2-12)

(1) The splitter direct drive clutch is released and the splitter overdrive clutch is engaged in second gear. When the splitter overdrive clutch is engaged, the splitter clutch drum and the splitter planetary sun gear are stationary. The splitter planetary carrier pinions, driven by the carrier which is attached to the drive plate on the engine flywheel, overdrive the splitter planetary ring gear. The ring gear is splined to the input shaft and drives the bevel gear.

(2) The remainder of the torque path, from the bevel drive gear to the output intermediate gear is the same as described in c, above.

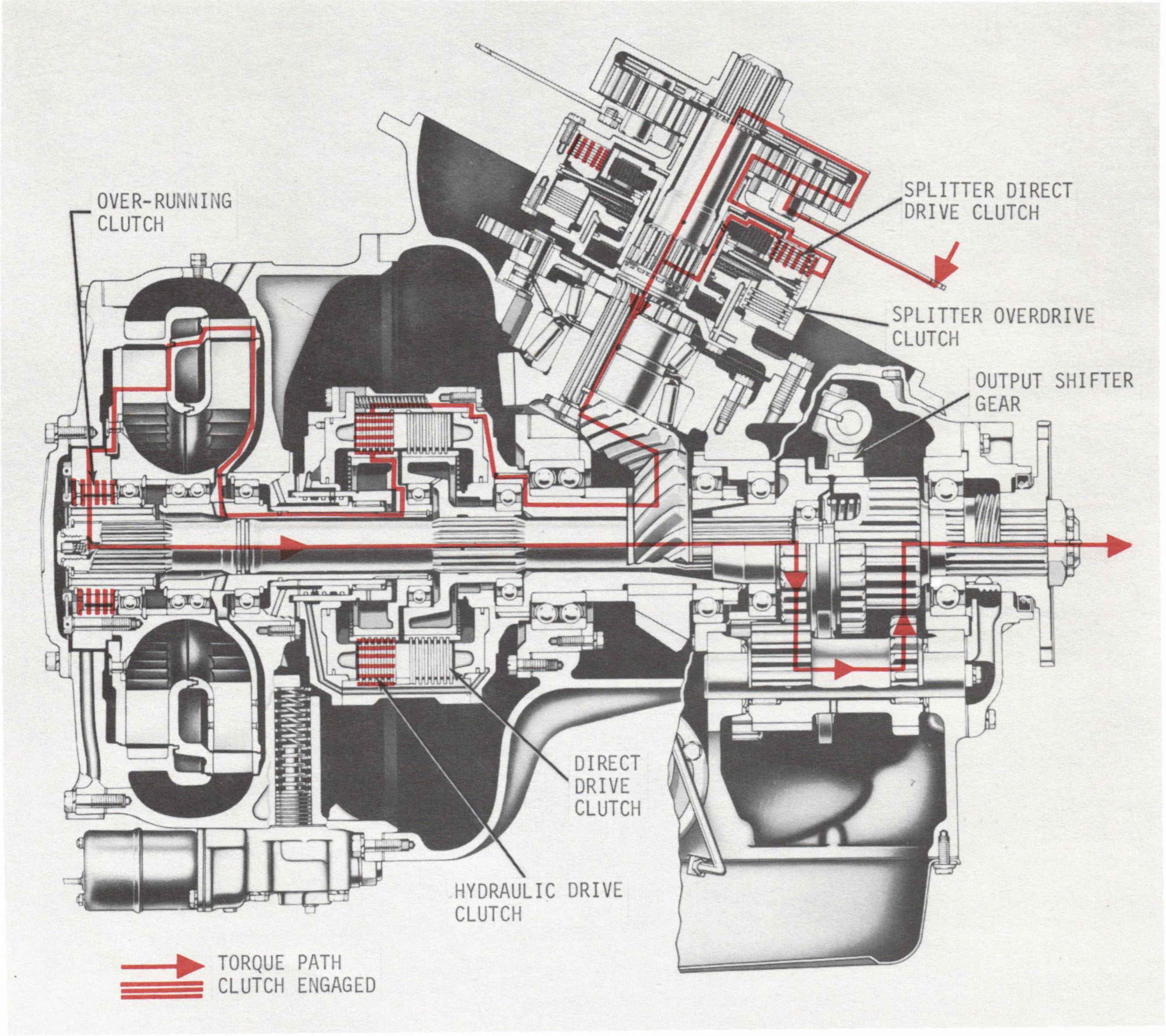

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Fig. 2-13 VS2 Series, reverse—torque path

m. VS2 Series, Reverse — Torque Path (fig. 2-13). The torque path for reverse mode is the same as described for the VH series in d, above.

Section 3. PREVENTIVE MAINTENANCE

3-1. SCOPE OF SECTION 3

This section outlines periodic and routine procedures required to maintain the transmission in good operating condition. Included are instructions for care of the oil system, minor adjustments of the transmission and controls, tests to determine condition, instructions for extended storage and troubleshooting.

3-2. PERIODIC INSPECTIONS, CLEANING

a. Inspecting Exterior. The exterior of the transmission should be cleaned and inspected at regular intervals. The severity of service and operating environment will determine the frequency of such inspections. The transmission should be inspected for loose bolts, oil leaks, linkage troubles and damaged or loose oil lines. Oil leaks require immediate attention. Linkage must be kept clean, properly adjusted and lubricated.

b. Cleaning Breather. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Clean the area around the breather base before removing the breather.

> Note: The breather is not furnished with the transmission. Follow the coach manufacturer's instructions on breather maintenance.

c. Water or Dirt in Oil.

(1) At each oil change, examine the oil that is drained for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water, check the cooler (heat exchanger) for leakage between the water and oil areas. Oil in the water side of the oil cooler (or vehicle radiator) is another sign of leakage. However, this may indicate leakage of oil from the engine into the cooling system. Any accumulation of sludge or soft dirt in the transmission sump should be removed by the use of "flushing oil."

(2) If engine coolant containing ethylene glycol leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected and cleaned. All traces of the coolant and varnish deposits resulting from coolant contamination must be removed.

(3) A Gly-Tek test kit to detect glycol in transmission oil can be obtained from Nelco Company, 1047 McKnight Road South, St. Paul, Minnesota 55119.

> Note: Some transmission oils will give a positive indication because of "additives" in the oil. When test results are questionable, test a clean (unused) sample of the same type or brand to confirm results.

d. Metal Particles in Oil

(1) Metal particles in the oil (except for the minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning of all internal and external circuits, cooler, and all other areas where the particles could lodge. However, repeated cleaning and flushing may not remove all debris from the oil cooler circuit.

(2) To prevent another failure caused by eventual movement of trapped debris, installation of an auxiliary filter between the oil cooler and transmission (in return line) is

recommended. This recommendation applies whether the failed transmission is overhauled or replaced by a new or rebuilt unit.

(3) Forty-micron filter assemblies such as PM 13-7 (P/N 5576446) with a filter element PF 132W (P/N 5573014), manufactured by AC Spark Plug, can be used satisfactorily. Maximum pressure drop across the new filter element must not exceed 3 psi (21 kPa) at 15 gpm (30 liters per minute) flow at 180°F (82°C)

3-3. OIL SYSTEM

a. Checking Oil Level

(1) The transmission oil level should be checked at least every 3000 miles (4827 km). Figure 1-4 shows the location of the oil level gage. Clean the area around the gage top before removing the gage. Unscrew the oil gage to remove it from the filler opening, Wipe the gage clean and re-insert it to the depth allowed without engaging the threads.

Note: The transmission must be at normal operating temperature and the oil should be checked immediately after engine shutdown. Otherwise the oil level reading will be false.

(2) The oil level gage (dipstick) should indicate an oil level between the Add and Full mark. Oil should be added only when the oil level falls to the Add mark (on the oil level gage) or below.

Note: Use only Dexron or Dexron II hydraulic transmission fluid.

(3) Replace the oil level gage by threading it into the oil filler opening and tightening it firmly.

b. Maintenance Intervals. The severity of service and the environment in which the transmission operates, will determine the frequency of some maintenance operations. Under very dusty or dirty operating conditions, the transmission oil and oil filter should be changed more often. Oil should be changed immediately if it has been subjected to overheating. The breather will require more frequent cleaning when dirt and dust conditions are severe. Generally, the transmission oil and filter should be changed every 25,000 miles (40,225 km) and the filter changed at shorter intervals, depending upon the condition of the oil. A dark color or burnt odor does not mean that Dexron fluid needs to be changed. A laboratory analysis is the only suitable method to determine the condition and serviceability of the oil.

c. Changing Oil Filters. Refer to vehicle manual for the procedures necessary to change the transmission oil filter element.

d. Draining Oil, Refilling

(1) The transmission should be as near temperature (180° to 200°F; 82 to 93°C) as possible when the oil is drained. Remove the oil drain plug (fig. 1-1 or 1-3) and the 1/8-inch pipe plug from the bushing at the lower side of the torque converter housing. Allow the transmission to drain thoroughly.

(2) Remove oil sump pan 28 (A, foldout 14) and gasket 1. Discard the gasket. Remove oil pump strainer screen 23 and clean thoroughly with mineral spirits, using a soft-bristle brush. Install the strainer screen and retain with the retaining spring 24. Clean the oil pan thoroughly.

(3) Place the oil pan gasket onto the oil pan. If adhesives or sealers are required to retain the oil pan gasket, they may be applied onto the pan mounting flange but only on the area outside the flange bead.

Caution: Do not use gasket-type sealing compounds any place inside the transmission or where they might get washed into the transmission. Also, do not use nonsoluble vegetable base cooking compounds or fibrous greases inside the transmission.

(4) Install the oil pan and gasket, carefully guiding them into place. Guard against dirt or foreign material entering the pan. Retain the pan to the housing with four 5/16-18

x 7/8 inch washer-head screws. Install each screw, by hand, one at a time, into each corner of the pan. Install the remaining 15 washer-head screws by hand, carefully threading each one through the gasket. Bottom all screws before tightening them.

(5) Alternately tighten screws 180 degrees apart to 5 lb-ft (6.8 Nm) torque. Repeat the process, tightening the screws to 17-20 lb ft (23-27 N·m) torque.

(6) Refill the transmission with Dexron or Dexron II hydraulic fluid to the Add mark on the level gage (refer to a, above).

> Note: Refill will not require as much oil as will initial fill. Initial fill requires 28 to 32 US quarts (26 to 30 liters), depending upon installation.

(7) Start and run the engine until the transmission operating temperature (180° to 200°F; 82 to 93°C) is reached. Then check oil level as outlined in a, above. Add oil, as necessary, until the oil is at the Full mark on the oil level gage. Install and tighten the oil level gage.

3-4. PRESSURES, TEMPERATURE

a. Check Points Similar for Both Models. Figure 3-1 illustrates the oil pressure check points on the transmission. The VS series transmission is illustrated. However, the pressure check points are identical for the VH series except for the lubrication pressure point, which is found only on the VS series. A plug at each check point is removed to attach a pressure check line.

b. Pressure Checks. Pressure checks must be made while the transmission is at normal operating temperature 180° to 200°F, 82 to 93°C). Refer to paragraph 1-7 for normal pressure range.

c. Maximum Temperature. The maximum temperature of the transmission oil at converter-out is 250°F (121°C).

3-5. SHIFT LINKAGE ADJUSTMENT

a. Refer to Coach Service Manual. The shift control linkage between the transmission and the operator's selector lever is not furnished by the transmission manufacturer, and may vary among installations. Refer to the vehicle service manual for specific instructions on linkage adjustments.

b. Shifter Lever Detents. The transmission shifter lever (fig. 1-1) has three detent positions. A spring-loaded detent locates the lever accurately in each position. The transmission is in forward mode when the shifter lever is in the detent that positions the lever towards the rear of the transmission (the torque converter end of the transmission). The transmission is in reverse mode when the shifter lever is in the detent that positions the lever towards the front of the transmission. The detent between these two positions is neutral. The linkage is correctly adjusted when the detent points on the transmission coincides with the detent points on the operator's selector lever (shift tower).

> Note: Air shift transmissions have no mechanical neutral. The shift lever passes through the neutral detent point but does not stop there.

3-6. CONTROL VALVE ADJUSTMENT

a. Shims. Two valves require the installations of shims to adjust their spring forces. One of these is direct drive clutch control valve 23 (B, foldout 14) located in the drive clutch control valve assembly and is used on VH transmissions with hydraulic governors and all VS series transmissions. (VH series transmissions with electro-mechanical governor, have a drive clutch control valve assembly with two solenoids, and do not require this adjustment.) The other valve is splitter clutch control valve 7 (foldout 15) located in the input splitter clutch control valve assembly, and used only on the VS2 series. Both valves respond to governor pressure (transmission output speed); there-

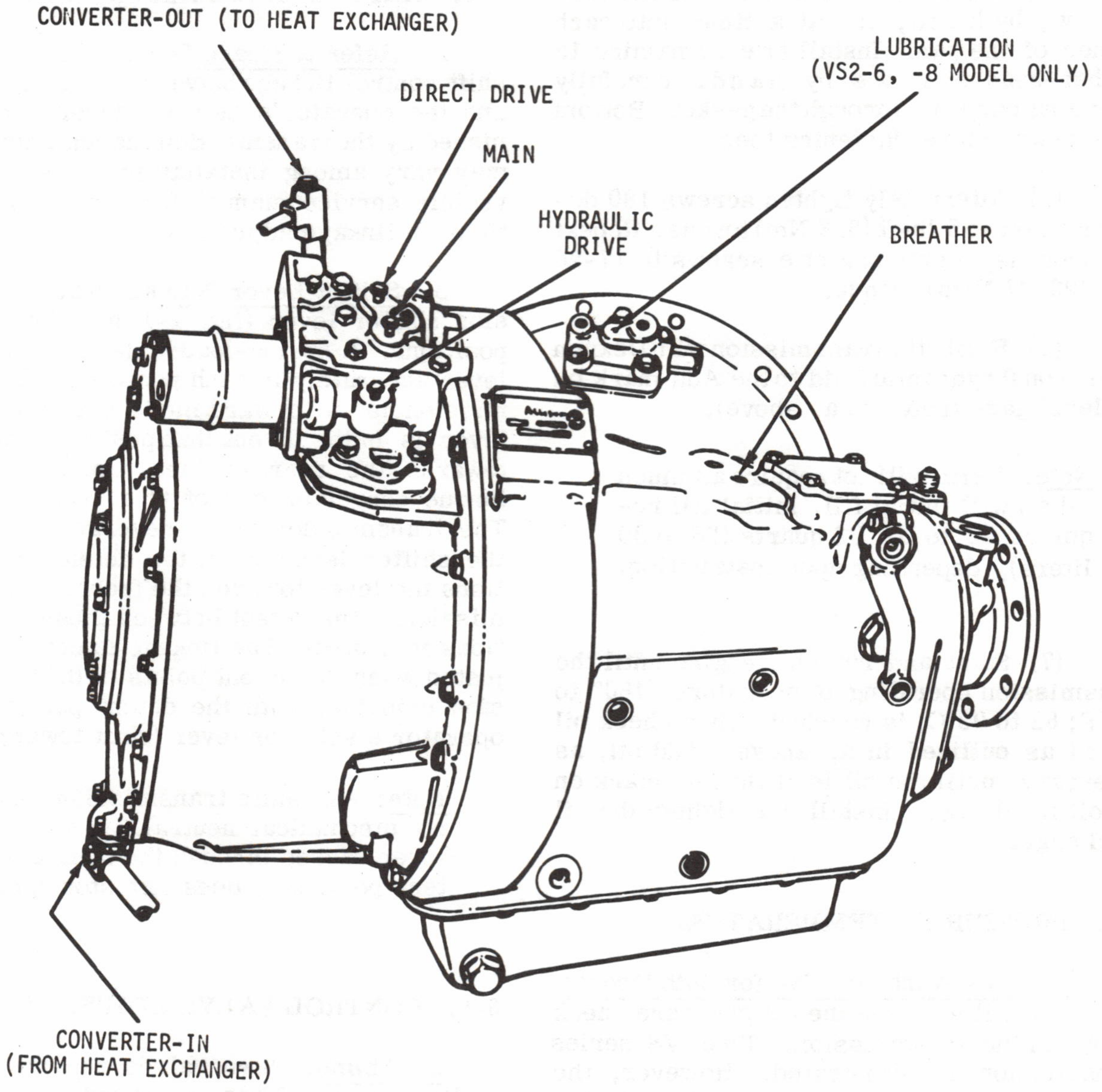
CONVERTER-OUT (TO HEAT EXCHANGER)
DIRECT DRIVE
MAIN
HYDRAULIC DRIVE
LUBRICATION (VS2-6, -8 MODEL ONLY)
BREATHER
CONVERTER-IN (FROM HEAT EXCHANGER)
6361A

Fig. 3-1. Oil pressure check points

fore, they can be adjusted to shift the transmission at the desired transmission output speed. When the valves are properly adjusted, the transmission should shift at the output speeds (rpm) listed in the chart in d, below.

b. Direct Drive Clutch Control Valve. To adjust this valve, add or remove shims 24 (B, foldout 14) between the valve 23 and spring 25. The valve should shift from hydraulic drive position (spring extended) to direct drive position (spring compressed) at the output speed shown in the chart in d, below. Shim the valve to obtain an upshift at a speed as near that prescribed as possible. Each added shim will increase the shift point approximately 25 rpm. Replace the spring if it cannot be shimmed to the proper output speed. Refer to paragraph 6-3d for assembly instructions.

c. Splitter Clutch Control Valve. To adjust this valve, add or remove shims 9 (foldout 15) seated in valve cap 12 or shims 23 seated in valve cap 20. Later model transmissions have the shims 9 on rivet 10 or shims 23 on rivet 22, which is then inserted into the cap. The valve should shift from splitter direct drive position (spring extended) to splitter overdrive position (spring compressed) at the transmission output speed shown in the chart in d, below. Shim the valve to obtain an upshift at a speed as near that prescribed as possible. Each added shim will increase the shift point approximately 50 rpm. Replace the spring if it cannot be adjusted to the proper output shaft speed without exceeding the following maximum number of shims. Refer to paragraph 6-4b and d for assembly instructions.

Spring P/N	Max. No. Shims
6835724	10
6835723	7
6830330	10

d. Valve Shim Chart. (Refer to b and c, above.) The following chart indicates speed (rpm) of the transmission output shaft at shift points, when valves are properly adjusted.

3-7. STALL SPEED TEST

a. Definition, Purpose

(1) A stall check determines conditions while the output shaft is prevented from rotating while the engine is running at full throttle. The stall test determines whether or not the engine and transmission are performing satisfactorily as a unit.

(2) The normal stall speed applicable to the specific engine-transmission combination must be known to properly evaluate the test. This data is available from your equipment dealer or distributor.

b. Procedure

WARNING: When conducting a stall speed test, the vehicle must be prevented from moving. Both the parking and service brakes must be applied and, if necessary, the vehicle should be blocked to prevent movement. Warn personnel to keep clear of the vehicle and its travel path.

Transmission Series or Model	VH Series	VS1 Series	VS2 Series
Direct drive clutch control valve:			
hydraulic drive to direct-drive (upshift)	1300	1300	1300
*direct drive to hydraulic drive (downshift)	1150	1150	1150
Splitter clutch control valve:			
splitter direct drive to splitter overdrive (upshift)	—	—	1940
*splitter overdrive to splitter direct drive (downshift)	—	—	1600

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*Do not attempt to shim valves to obtain downshift speeds. These only are approximate values to be utilized in troubleshooting. Excessive variations from these downshift speeds may indicate improper torque on valve body mounting bolts. These bolts should be uniformly tightened to 26 to 32 pound feet (35 to 43 N• m) torque.

(1) Connect a tachometer of known accuracy to the engine and bring the transmission to operating temperature (180° to 200°F; 82 to 93°C). Apply the parking brake, block the vehicle wheels for added safety and apply the vehicle service brakes. Shift the transmission to forward operating mode and accelerate the engine to full throttle.

Caution: Do not operate engine at stall speed for longer than 30 seconds at a time. Do not allow converter-out oil temperature to exceed 250°F (121°C).

(2) Note the engine speed attained during the stall test and compare it with the normal speed for the particular engine-transmission combination being tested. Refer to the Troubleshooting Chart at the end of this section for possible causes of stall speed deviations from normal.

Note: Because of the effects of ambient temperature, altitude, engine accessory power loss variations, etc., on power input to the torque converter, the actual engine stall speed may vary ± 150 rpm from the established normal value. When the deviation can be attributed to such causes, the actual speed can be accepted as normal.

3-8. PRESERVATION AND STORAGE

a. Storage, New Transmissions (prior to installation). New transmissions are tested with preservative oil and drained prior to shipment. The residual oil remaining in the transmission provides adequate protection to safely store the transmission for six weeks without further treatment.

b. Preservation Methods. When the transmission is to be stored or remain inactive for an extended period (up to one year), specific preservation methods are recommended to prevent damage due to rust, corrosion, and organic growth in the oil. Preservation methods are presented for storage with and without oil.

c. Storage, One Year—Without Oil

(1) Drain the oil and replace the oil filter element(s) (para 3-3d).

(2) Seal all openings and breathers with moisture-proof tape.

(3) Coat all exposed, unpainted surfaces with preservative grease such as petrolatum (MIL-C-11796, Class 2).

(4) Atomize or spray 2 ounces (60 milliliters) of Motorstor®*, or equivalent, into the transmission through the oil pan drain plug.

(5) If additional storage time is required, repeat (2) and (3) above at yearly intervals.

d. Storage, One Year—With Oil

(1) Drain the oil and replace the oil filter element(s) (para 3-3d).

(2) Fill the transmission to operating level with a mixture of one part Motorstor (or equivalent) to 30 parts Dexron or Dexron II transmission fluid. Add 1/4 teaspoon of Biobor JF®** (or equivalent) for each 3 gallons (11 liters) of fluid in the system.

Note: When calculating the amount of Biobor JF required, use the total volume of the system, not just the quantity required to fill the transmission. Include external lines, filters, and the cooler.

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*Motorstor® is the registered trademark for a vapor phase rust preventive manufactured by Daubert Chemical Company, Chicago, Illinois. Motorstor is covered by Military Specifications MIL-L-46002 (ORD) and MIL-I-23310 (WEP) under the designation of Nucle Oil.

**Biobor JF® is the registered trademark for a biological inhibitor manufactured by U.S. Borax and Chemical Corporation.

(3) Run the engine for approximately five minutes at 1000 rpm with the transmission in neutral.

(4) Drive the vehicle. Make sure the transmission shifts through all ranges.

(5) Continue running the engine at 1000 rpm with the transmission in neutral until normal operating temperature is reached.

Caution: If the unit does not have a converter-out temperature gage, do not stall the converter.

(6) If normal operating temperature is less than 225°F (107°C), shift the transmission to a forward range and stall the converter. When converter-out temperature reaches 225°F (107°C), stop the engine. Do not exceed 225°F (107°C).

(7) As soon as the transmission is cool enough to touch, seal all openings and the breather with moisture-proof tape.

(8) Coat all exposed, unpainted surfaces with preservative grease such as petrolatum (MIL-C-11796, Class 2).

(9) If additional storage time is required, repeat (2) through (8) at yearly intervals; except, it is not necessary to drain the transmission each year. Just add Motorstor and Biobor JF (or equivalents).

e. Restoring Transmission to Service

(1) Remove all tape from openings and the breather.

(2) Wash off all external grease with mineral spirits.

(3) If the transmission is new, drain the residual preservative oil. Refill the transmission to the proper level (para 3-3a) with Dexron or Dexron II transmission fluid.

(4) If the transmission was prepared for storage without oil, refill the transmission to the proper level (para 3-3a) with Dexron or Dexron II transmission fluid.

(5) If the transmission was prepared for storage with oil, it is not necessary to drain and refill the transmission with new transmission fluid. Check for proper fluid level (para 3-3a). Add or drain transmission fluid as required to obtain the proper level.

3-9. TROUBLESHOOTING

a. Importance. Troubleshooting is the systematic search for and location of malfunctions in the engine or transmission, which affect transmission performance. A thorough study of the description and operation of components and of the hydraulic system (Section 2) will be helpful in troubleshooting. The engine and transmission must be regarded as a single package during troubleshooting.

b. Troubleshooting Chart. The following chart outlines the possible causes and remedies for a particular malfunction. When applicable, the remedies are further referenced to the section and paragraph containing the detailed information required for corrective action.

TROUBLESHOOTING CHART

Cause	Remedy
Ⓐ LOW MAIN PRESSURE	
1. Low oil level	1. Add oil (para 3-3a)
2. Main-pressure regulator valve spring weak or broken	2. Replace oil pump (para 6-5)
3. Main-pressure regulator valve sticking open	3. Free valve (para 6-5)
4. Oil pump worn	4. Replace oil pump (para 6-5)
5. Oil leaks in system	5. Check for leaks in lines, fittings, gaskets, piston seals (sect. 5, 6, 7)
6. Aerated oil, or incorrect oil in system (refer to D, below)	6. Check for leaks, overheating, high oil level; change to proper oil (para 3-2, -3)
Ⓑ OVERHEATING	
1. High or low oil level	1. Establish proper oil level (para 3-3)
2. Clutch failed	2. Repair clutch (sect. 5, 6, 7)
3. Vehicle overloaded	3. Reduce load
4. Low main pressure	4. Refer to Ⓐ, above
5. Engine overheated	5. Correct engine cooling troubles
6. Heat exchanger clogged	6. Clean heat exchanger
7. Water circuit to heat exchanger restricted	7. Inspect entire circuit, remove restrictions
Ⓒ LOW CLUTCH APPLY PRESSURE	
1. Low main pressure	1. Refer to Ⓐ, above
2. Clutch piston seals leaking	2. Replace seals (sect. 5, 6, 7)
3. Leaks in valve body mounting gaskets	3. Replace gaskets (sect. 5, 6, 7)
4. Leaks in internal lines or fittings	4. Repair or replace lines or fittings (sect. 5, 6, 7)
Ⓓ AERATED (foaming) OIL	
1. Incorrect type oil in system	1. Drain and refill with proper oil (para 3-3)
2. Low or high oil level	2. Establish proper oil level (para 3-3)
3. Air entering suction side of oil pump	3. Repair or replace oil pump (para 6-5)
Ⓔ VEHICLE WILL NOT TRAVEL	
1. Gears not shifting	1. Check linkage (para 3-5)
2. Clutch slipping	2. Replace clutch (sect. 5, 6, 7)
3. Low main pressure	3. Refer to A, above
4. Failed mechanical components	4. Overhaul transmission (sect. 5, 6, 7)
5. Solenoid not functioning properly	5. Check electrical circuit (refer to coach manual)
Ⓕ VEHICLE TRAVELS IN NEUTRAL WHEN ENGINE IS ACCELERATED (applies only to systems with hydraulic clutch engaged in neutral)	
1. Linkage not adjusted	1. Adjust linkage (para 3-5)

TROUBLESHOOTING CHART (Continued)

Ⓖ VEHICLE WILL TRAVEL ONLY ONE DIRECTION

Cause	Remedy
1. Linkage not adjusted	1. Adjust linkage (para 3-5)

Ⓗ SHIFT TO DIRECT DRIVE OCCURS AT WRONG SPEED

Cause	Remedy
1. Spring on clutch control valve weak or broken	1. Replace or shim spring (para 3-6)
2. Clutch control valve sticking	2. Free valve (para 6-3)
3. Valve body bolts incorrectly tightened	3. Tighten bolts properly (para 3-6)
4. Clutch control valve not properly shimmed	4. Adjust valve by shimming (para 3-6)
5. Governor failed	5. Replace governor (refer to coach manual)

Ⓘ SHIFT TO OVERDRIVE OCCURS AT WRONG SPEED (VS2 series only)

Cause	Remedy
1. Spring on splitter clutch control valve weak or broken	1. Replace or shim spring (para 3-6)
2. Splitter clutch control valve sticking	2. Free valve (para 6-4)
3. Valve body bolts incorrectly tightened	3. Tighten bolts properly (para 3-6)
4. Splitter clutch control valve not properly shimmed	4. Adjust valve by shimming (para 3-6)
5. Governor failed	5. Replace governor (refer to coach manual)

Ⓙ VEHICLE WILL NOT TRAVEL IMMEDIATELY AFTER STARTING ENGINE

Cause	Remedy
1. Torque converter air locked (Refer to D, above)	1. Check for leaks, overheating, improper oil level, anti-foaming characteristics of oil

Ⓚ STALL SPEED TOO LOW (refer to para 3-7)

Cause	Remedy
1. Engine not producing full power	1. Tune engine (refer to engine service manual)
2. Transmission not warm	2. Run engine in neutral until transmission sump is at normal temperature (180° to 200°F)

Ⓛ STALL SPEED TOO HIGH (refer to para 3-7)

Cause	Remedy
1. Hydraulic drive clutch slipping	1. Repair or replace clutch (sect. 5, 6, 7)
2. Low main pressure	2. Refer to A, above
3. Direct drive splitter clutch slipping (VS2 series only)	3. Repair or replace clutch (sect. 5, 6, 7)

Section 4. GENERAL OVERHAUL INFORMATION

4-1. SCOPE OF SECTION 4

This section provides preliminary information necessary for the overhaul of a transmission. Tools and equipment needed are discussed. Replacement parts information is provided. The importance of cleanliness and careful handling is stressed. General information on the removal and installation of the transmission is included. Standard and special torque specifications for bolts and nuts are tabulated. Wear limits and spring information are referenced.

4-2. CHANGES IN MODELS, PROCEDURES

The release of new assemblies and/or product improvements may require the use of new or different procedures. Consult your dealer or distributor for the latest information. Give the information from the transmission nameplate, as outlined in paragraph 1-4a, when requesting information.

4-3. TOOLS, EQUIPMENT NEEDED

a. Common Tools, Equipment. In addition to the tools commonly available to the mechanic, the following items should be available.

(1) Chain hoist (at least 1/2-ton)

(2) Suitable work table

(3) Press (for removal, installation of press-fit parts)

(4) Supply of wood blocks

(5) Clean wiping cloths (do not use linty waste)

(6) Parts receptacles

(7) Cleaning equipment (brushes, solvent, etc.)

(8) Torque wrenches

(9) Oil-soluble grease (Petrolatum)

(10) Dry ice (for cooling press-fit parts)

(11) Heat lamps (for expanding housing bores when installing bearing retainers)

(12) Snapring pliers (for both internal, external rings)

b. Special Tools. Special tools helpful or necessary for overhaul are available from:

Kent-Moore Tool Division
1501 South Jackson Street
Jackson, Michigan 49203

All inquiries, orders, etc., concerning special tools, should be directed to the above organization. A list of the special tools, with references to their use follows.

4-4. REPLACEMENT PARTS

a. Ordering Information. Refer to paragraph 1-4 for information on ordering replacement parts.

b. Parts Normally Replaced. The following parts are normally replaced at each overhaul.

(1) Gaskets

(2) Cotter pins

(3) Lockwire

(4) Lockstrips

Tool No.	Tool Name	Para Ref
J-2619	Slide hammer	5-3k(2)
J-7441	Rear bearing retainer remover	6-9a(5)
J-8176	Bevel gear and front bearing remover	6-9a(2), 6-9b(9)
J-24202-4	Bearing installer	6-9b(3), (7)
J-25456-1	Bevel gear sleeve nut wrench (use with J-26552)	6-9a(2), 6-9b(10)
J-26404	Bevel gear retainer bearing installer (use with J-24202-4)	6-9b(3)
J-26405	Transmission holding fixture	4-7c
J-26551	Bevel gear loading fixture	6-9a(2), 6-9b(9)
J-26552	Bevel gear nut wrench pilot adapter (use with J-25456-1)	6-9a(2), 6-9b(9)

Note: The tools defined in this table may have a different configuration than those shown in the illustrations.

(5) Washers or snaprings damaged by removal

(6) Oil seals (when removed)

Caution: Do not burn discarded Teflon sealrings. Toxic gases are produced by burning Teflon.

c. Service Kits. Make use of the repair and overhaul kits which are available. See paragraph 1-4 on how to order.

4-5. CAREFUL HANDLING

During all rebuild procedures, parts and subassemblies must be handled carefully to prevent nicking, scratching and denting. Parts which fit together closely, but with operating clearance, will stick if damaged only slightly. Parts which depend upon smooth surfaces for sealing may leak if scratched. Such parts should be carefully handled and protected during removal, cleaning, inspection and installation.

4-6. CLEANING, INSPECTION

a. Dirt Causes Malfunction. All parts must be clean to permit effective inspection. At assembly, it is very important that no dirt or foreign material be allowed to enter the transmission. Even minute particles can cause the malfunction of close-fit parts, such as valves.

b. Cleaning Parts

(1) All the metallic parts of the transmission except bearings and friction-faced clutch plates should be cleaned thoroughly with volatile mineral spirits or by the steam-cleaning method. Do not use caustic soda solution for steam cleaning.

(2) Parts should be dried with compressed air. Steam-cleaned parts should be oiled immediately after drying.

(3) Clean oil passages by working a piece of soft wire back and forth through the passages and flushing with spirits. Dry the passages with compressed air.

(4) Examine parts, especially oil passages, after cleaning, to make certain they are entirely clean. Reclean them, if necessary.

c. Cleaning Bearings

Caution: If excessive metal contamination has occurred, replacement of all bearings within the transmission is recommended.

(1) Bearings that have been in service should be thoroughly washed in volatile mineral spirits.

(2) If the bearings are particularly dirty or filled with hardened grease, soak them in the spirits before trying to clean them.

WARNING: Never dry bearings by spinning them with compressed air. A spinning bearing can disintegrate, allowing balls or rollers to become lethal flying projectile. Also, spinning bearings while they are not lubricated can damage the bearing.

(3) Before inspection, oil the bearings with the same type of oil that will be used in the transmission.

d. Keeping Bearings Clean. Since the presence of dirt or grit in ball bearings is usually responsible for bearing failures, it is important to keep bearings clean during removal and installation. Observance of the following rules will do much to insure maximum bearing life.

(1) Do not remove the wrapper from new bearings until ready to install them.

(2) Do not remove the grease in which new bearings are packed.

(3) Do not lay bearings on a dirty bench; place them on clean paper.

(4) If assembly is not to be completed at once, wrap or cover the exposed bearings with clean paper or cloth to keep out dust.

e. Inspecting Cast Parts, Machined Surfaces

(1) Inspect bores for wear, scratches, grooves and dirt. Remove scratches and burs with crocus cloth. Remove foreign matter. Replace parts that are deeply scratched or grooved.

(2) Inspect all oil passages for obstructions. If an obstruction is found, remove it with compressed air, or by working a soft wire back and forth through the passage and flushing it out with cleaning solvent.

(3) Inspect mounting faces for nicks, burs, scratches, and foreign matter. Remove such defects with crocus cloth or a soft stone. If scratches are deep, replace the defective part.

(4) Inspect threaded openings for damaged threads. Chase damaged threads with the correct size used tap.

(5) Replace housings or other cast parts that are cracked.

(6) Inspect all machined surfaces for damage that could cause oil leakage or other malfunction of the part. Rework or replace the defective parts.

f. Inspecting Bearings

(1) Inspect bearings for roughness of rotation. Replace a bearing if its rotation is still rough after cleaning and oiling.

(2) Inspect bearings for scored, pitted, scratched, cracked, or chipped races, and for indication of excessive wear of rollers or balls. If one of these defects is found, replace the bearing.

(3) Inspect a defective bearing's housing and shaft for grooved, burred or galled conditions that indicate the bearing has been turning in its bore or on its shaft. If the damage cannot be repaired with crocus cloth, replace the defective part.

(4) When installing a bearing on a shaft, coat the mating surfaces with white lead and use the proper size installation sleeve and a press to seat the bearing.

(5) If a bearing must be removed or installed without a sleeve, press only on the race which is adjacent to the mounting surface. If a press is not available, seat the bearing with a drift and a hammer, driving against the supported race.

g. Inspecting Bushings, Thrust Washers

(1) Inspect bushings for scores, burs, roundness, sharp edges and evidence of overheating. Remove burs with crocus cloth. Remove sharp edges with a scraper or knife blade. If the bushing is out-of-round, deeply scored, or excessively worn, replace it, using the proper size replacer tool.

Note: Sometimes it is necessary to cut out a defective bushing. Be careful not to damage the bore into which the bushing fits.

(2) Inspect thrust washers for distortion, scores, burs, and wear. Replace the thrust washer if it is defective or worn. It is much less expensive to replace such parts than to replace converter elements or transmission components that can fail due to defective bearings, bushings, or thrust washers.

h. Inspecting Oil Seals, Gaskets

(1) Inspect sealrings for cuts and hardness. Replace sealrings if these defects are found.

(2) When replacing lip-type oil seals, the spring-loaded side must be toward the oil to be sealed in (toward the inside of the unit). Use a nonhardening sealing compound on the outside diameter of the seal to help prevent oil leaks. Coat the inside diameter of the seal with high-temperature grease (MIL-G-3545A, or equivalent) to protect the seal during shaft installation and to provide lubrication during initial operation.

(3) Replace all composition gaskets.

(4) Inspect hook-type sealrings for wear, broken hooks, and distortion.

(5) Install a new hook-type sealring if ring shows wear on outside diameter or excessive side wear.

(6) The sides of the sealring must be smooth (0.005-inch maximum side wear). The sides of the shaft groove (or the bore), in which the sealring fits, should be smooth (50 microinches equivalent) and square with the axis of rotation within 0.002 inch. If the sides of the grooves have to be reworked, install a new sealring.

i. Inspecting Gears

(1) Inspect gears for scuffed, nicked, burred or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

(2) Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

(3) Inspect the thrust face of gears for scores, scratches, and burs. Remove such defects with a soft stone. If scratches and scores cannot be removed with a soft stone, replace the gear.

j. Inspecting Splined Parts. Inspect splined parts for stripped, twisted, chipped or burred splines. Remove burs with a soft stone. Replace the part if other defects are found. Spline wear is not considered detrimental except where it affects tightness of fit of the splined parts.

k. Inspecting Threaded Parts. Inspect parts for burred or damaged threads. Remove burs with a soft stone or fine file. Replace damaged parts.

l. Inspecting Snaprings. Inspect all snaprings for nicks, distortion, and excessive wear. Replace the snapring if any of these defects is found. The snapring must snap tight in its groove for proper functioning.

m. Inspecting Springs. Inspect springs for signs of overheating, permanent set, or wear due to rubbing adjacent parts. Replace the spring if any one of these defects is found. Refer to the spring chart at the end of Section 8. Replace springs which do not meet specifications.

n. Inspecting Clutch Plates

(1) Inspect friction-faced plates for burs, imbedded metal particles, severely pitted faces, excessive wear, cone, cracks, distortion, and damaged spline teeth. Remove burs, using a soft honing stone. Replace plates which have other defects.

(2) Inspect steel plates for burs, scoring, excessive wear, distortion, galling, cracks, breaks, and damaged tangs. Remove burs and minor surface irregularities, using a soft honing stone. Replace plates which have other defects.

(3) When assembling a clutch pack, soak the plates in Dexron transmission fluid for at least 2 minutes prior to installation.

4-7. GENERAL ASSEMBLY PROCEDURES

a. Clutches, Pistons

(1) Clutch pack clearances must be established prior to assembly. After clearances have been established, soak each friction-face clutch plate (2 minute minimum) in transmission fluid prior to final assembly.

(2) Apply a generous amount of transmission fluid to the piston cavity prior to final assembly.

(3) Assemble clutch plates so that the cone of each plate faces the same direction as the cone of the adjacent plates.

b. Lubricants Used For Assembly. Use transmission fluid to lubricate splines, bearings, clutch plates, etc. during assembly. A low temperature grease, such as petrolatum, shall be used for internal assembly where it is necessary to use a grease to hold parts in place for assembly. The grease shall have a melting point of 100-140°F (38-60°C) and must be completely soluable in the transmission fluid. Petrolatum equivalent to MIL-VV-236 or Amojell Petrolatum (Amoco Oil Co.) is recommended. High temperature grease having good oxidation and water resistance shall be used at the ID of input and output shaft oil seals. A high temperature grease equivalent to MIL-G-81322, Mobil grease No. 28 (Mobil Oil Co.), or Aeroshell grease No. 22 (Shell Oil Co.) is recommended.

c. External Plugs, Hydraulic Fittings

Caution: Do not use Teflon tape on threaded parts. Slivers can get into the oil and cause the transmission to malfunction.

Prior to installation, apply a small amount of non-hardening sealant into the threads of each plug or fitting. Tighten the plugs or fittings sufficiently to prevent leakage.

d. Oil-soluble Grease

Caution: Do not use oil-soluble grease to retain cork gaskets.

Use oil-soluble grease with a low melting point (petrolatum) to temporarily retain parts, step-joint sealrings, scarf-cut sealrings, and hook-type sealrings during assembly with mating parts.

e. Sealring Compounds, Nonsoluble Greases

Do not use gasket-type sealing compounds, fibrous greases, or nonsoluble, vegetable-base cooking compounds any place inside the transmission. Do not use them any place where they could be flushed into the transmission hydraulic system. However, if adhesives or sealers are required for the oil pan gasket, they may be applied on the pan mounting flange, but only in the area outside of the flange bead.

f. Lip-type Oil Seals

(1) When replacing lip-type oil seals, make sure the spring-loaded lip side is toward the oil to be sealed in (toward the inside of the unit). Coat the ID of the seal with high temperature grease (MIL-G-81322 or equivalent) to protect the seal during shaft installation and to provide lubrication during initial operation.

(2) The circumference of some seals is precoated with a dry sealant. The sealant is usually colored for easy identification. The precoated seals do not require any additional sealant before installation.

(3) The circumference of some seals is not precoated with a dry sealant. A nonhardening sealant should be applied to the circumference of these seals before installation.

g. Interference-fit Parts

Assembly of interference-fit parts may be accomplished by heating and chilling the respective parts. The female part can be heated in an oven or oil bath to 300°F (149°C), and the male part can be chilled in dry ice. Either one or both parts may require a thermal process. However, if the chill process is used for a ferrous alloy part, coat the components with transmission fluid to inhibit rust due to frost and moisture.

h. Sleeve-type Bearings and Bushings

The use of a locking compound is recommended to retain bushings and sleeve-type bearings that have press-fit tolerances. One such compound is Loctite Sleeve Retainer 601. This compound or equivalent should be used.

i. Bearings (Ball or Roller)

(1) When installing a bearing on a shaft, heat the bearing to 200°F (93°C) on an electric hot plate or in an oil bath. Coat the mating surfaces with white lead and use the proper size installation sleeve and a press to seat the bearing.

Note: Bearings must be heated long enough for sufficient expansion. Heating time is determined by the size of the bearing. Forty-five minutes is sufficient for the largest bearing in these transmissions.

(2) If a bearing must be removed or installed without a sleeve, be careful to drive or press only on the race which is adjacent to the mounting surface. If a press is not available, seat the bearing with a drift and a hammer, driving against the supported race.

4-8. WEAR LIMITS

Refer to Section 8 for general and specific information covering parts fits, clearances and wear limits.

4-9. SPRING INFORMATION

Refer to the spring charts in Section 8 for spring identification and specifications.

4-10. REMOVING, INSTALLING TRANSMISSION

a. Drain Oil. Drain the oil from the transmission. For better drainage, the transmission should be warm and allowed to drain overnight. Replace the drain plug. Consult the vehicle service manual for specific instructions for removal and installation, as applications will differ.

b. Check Linkages, Lines. Make sure that all linkages, controls, cooler and filter lines, temperature and pressure connections, input and output couplings, and mounting bolts are disconnected before transmission removal. Oil lines should be carefully placed out of the way of damage and all openings covered to keep them clean. Clean the exterior of the transmission. Steam cleaning should be followed immediately by disassembly since condensation should not be allowed to remain in the transmission to cause rust.

c. Lifting Holes. Three 3/4-10 tapped holes are provided on the right side of the transmission housing. Adapter J-26205 used with a transmission dolly or work stand may be attached by bolts in these holes.

d. Input Planetary Carrier Assembly (VS2 series)

(1) The VS2 series transmission has an input planetary carrier assembly, consisting of an input ring gear and planetary carrier with drive plate. Some applications have the drive plate bolted to the engine flywheel with 12 bolts. Therefore, the carrier assembly will remain with the engine when the transmission is removed. Some applications have a torsional isolator on the engine flywheel with the drive plate splined into the torsional isolator. Thus, the carrier assembly could remain with the engine flywheel or remain with the transmission, when removed.

Note: Do not allow the carrier assembly to fall from the flywheel or input shaft when removing transmissions having the drive plate splined into a torsional isolator. During removal of the transmission, remove the carrier assembly from the splines of the torsional isolator and input shaft.

(2) To remove carrier assembly, bolted to the engine flywheel, remove 12 bolts attaching the drive plate to the flywheel. Remove the drive plate (with carrier assembly) and ring gear from the flywheel.

e. Reconnect at Installation. At installation, all items removed or disconnected should be reconnected. Refer to the vehicle service manual for specific instructions.

4-11. TEFLON SEALRINGS, EXPANDERS

a. Applies to All Clutches

(1) These instructions will apply to all clutches in which Teflon sealrings and steel expanders are used.

(2) Disassembly and rebuild procedures are referenced to this paragraph for removal and installation of Teflon sealrings and expanders.

b. Removal

WARNING: Do not burn discarded Teflon seals. Toxic gases are produced.

(1) Do not remove Teflon sealrings by the use of sharp edged or pointed tools, if the sealrings are to be reused. Place a thin, flat bladed tool into the sealring groove, and work one edge of the sealring out of the groove, until it can be grasped with the fingers.

(2) Remove sealring expander. Clean the sealring groove thoroughly and remove any nicks, burs or rough spots.

c. Assembly

(1) Coil the expanders as shown in figure 4-1. Inspect the expander ends for curvature toward the bottom of the sealring grooves (inward for external grooves; outward for internal grooves).

(2) Install the expander into the groove.

(3) Starting at a point opposite the open ends of the expander, install the Teflon sealring. Do not stretch or deform the sealring more than absolutely necessary for installation. Work both directions from the starting point until the sealring is completely installed. Do not use tools to force the sealring — use fingers only.

(4) Lubricate the sealring and center it radially in respect to the piston or part on which it is installed.

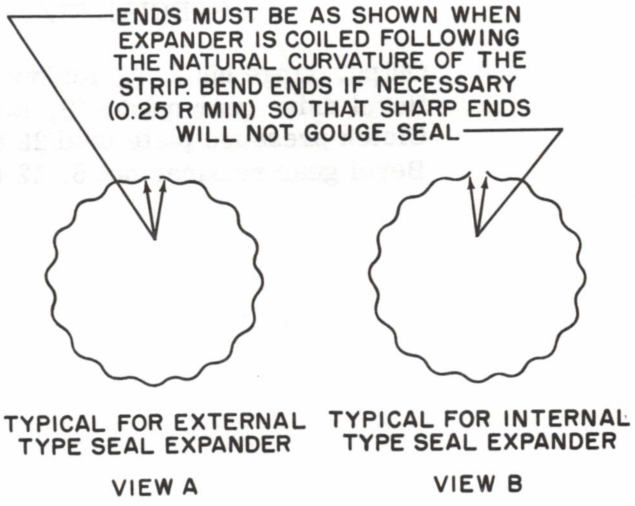

ENDS MUST BE AS SHOWN WHEN EXPANDER IS COILED FOLLOWING THE NATURAL CURVATURE OF THE STRIP. BEND ENDS IF NECESSARY (0.25 R MIN) SO THAT SHARP ENDS WILL NOT GOUGE SEAL
TYPICAL FOR EXTERNAL TYPE SEAL EXPANDER
VIEW A
TYPICAL FOR INTERNAL TYPE SEAL EXPANDER
VIEW B
6228

Fig. 4-1. Teflon sealring expanders

4-12. WEAR LIMITS, SPRING INFORMATION

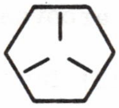
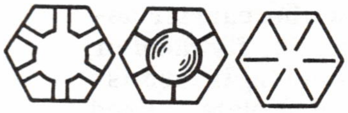
Refer to Section 8 for wear limits and spring data.

4-13. TORQUE SPECIFICATIONS

The assembly procedures in Sections 6 and 7 specify the torque requirement of each bolt and nut. In addition, for convenient reference, all torque requirements are tabulated below.

STANDARD TORQUE SPECIFICATIONS

Note: All torque values are given in pound feet (newton meters).

Size	Threads per inch	Standard heat-treated bolts and screws	Special heat-treated bolts screws, Allen-head screws and self-locking capscrews	Nuts
				
1/4	20	6-8 (8-11)	9-11 (12-15)	
	28	8-10 (11-14)	10-12 (14-16)	
5/16	18	13-16 (18-22)	17-20 (23-27)	
	24	14-18 (19-24)	19-23 (26-31)	
3/8	16	26-32 (35-43)	36-43 (49-58)	
	24	33-40 (45-54)	41-49 (56-66)	17-20(23-27)
7/16	14	42-50 (57-68)	54-65 (73-88)	
	20	50-60 (68-81)	64-77 (87-104)	
1/2	13	67-80 (91-108)	81-97 (110-132)	
	20	83-100 (113-136)	96-115 (130-156)	

SPECIAL TORQUE SPECIFICATIONS

Output flange nut 2 (A, foldout 11)	300 (408)
Bevel drive gear nut 35 (B, foldout 9)	350 to 400 (475-542)
Clutch pressure plate stud 28 (B, foldout 12)	16 to 19 (22-26)
Bevel gear retainer nut 6, 12 (A, foldout 10)	25 to 30 (34-41)

Section 5. DISASSEMBLY OF TRANSMISSION INTO SUBASSEMBLIES

5-1. SCOPE OF SECTION 5

a. Models Covered. This section describes the disassembly of VH and VS series transmissions.

b. Disassembly Sequence

(1) The sequence of instructions is divided into major groups applicable to:

- VH and VS Series — removal of external components, torque converter, drive control valve, over-running clutch, output flange, end cover, output shaft, main housing, oil pump and oil pan.
- VH and VS1 Series — removal of matched bevel gears, direct and hydraulic clutches.
- VS2 Series — removal of input splitter clutches, matched bevel gears, drive clutches and splitter clutch control valve body.

(2) Each group is identified with the models to which the procedures apply. Any procedure not applicable to the transmission being disassembled may be disregarded, and disassembly continued with the next applicable procedure.

c. Illustrations

(1) Disassembly is referenced primarily to photographs in this section. When necessary, procedures are referenced to parts exploded views (foldout 9 through 15) at the back of the manual.

(2) In addition to the photographs and exploded views, there are two cross-section views (foldouts 1 and 2) in the back of the manual. These show the assembled relationship of parts and are helpful in determining the most expedient method of removing given components during partial disassembly.

5-2. SERVICING OF VEHICLE-MOUNTED TRANSMISSION

a. Service, Maintenance. The VH and VS transmissions are designed so that some service and maintenance operations can be accomplished without removing the transmission from the vehicle. The disassembly procedures in this manual, however, illustrate the operations with the transmission removed.

b. Accessibility. The nature of the service required and the accessibility to that area (or component) will determine the advisability of performing major operations without removing the transmission. Although the procedures for disassembly are essentially the same, the position of the transmission may cause some inconvenience at times. A close inspection should be made, and the foregoing factors weighed, before deciding if the transmission should be removed. Listed below are the transmission components or subassemblies that may normally be removed with the transmission in the vehicle:

(1) Drive clutch control valve assembly

(2) Splitter clutch control valve assembly (VS2 only)

(3) Over-running clutch and drive shaft

(4) Torque converter and housing

(5) Oil (sump) pan

(6) Oil pump

(7) Hydraulic, direct drive clutch pack

5-3. DISASSEMBLY PROCEDURES

a. Removing Exterior Components

(1) The transmission assembly can be raised from the floor or dolly by use of a

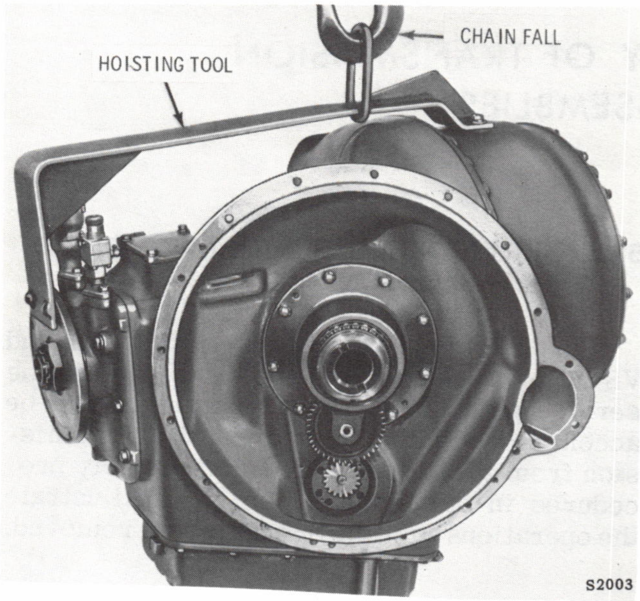


Fig. 5-1. Lifting transmission

suitable hoisting tool (fig. 5-1). One end of the tool is equipped with pins which engage holes in the transmission output flange and the other end is attached by bolts at the cooler line fitting holes on top of the converter housing. During overhaul procedures, the unit should be mounted in a workstand (fig. 5-2). Raise the unit high enough to aline the tapped holes in the transmission housing with holes in the workstand adapter. Insert three bolts (3/4-10 x 1 1/2) through the stand adapter and into the transmission housing (fig. 5-2).

(2) Remove seven bolts and lockwashers from the drive clutch control valve assembly (fig. 5-3).

(3) Remove the valve assembly, gasket 5 (B, foldout 14), accumulator valve 4, spring 2 and spring 3. Refer to paragraph 6-3 for rebuild of the drive clutch control valve assembly.

(4) On the VS2 series only, remove three bolts and lockwashers from splitter clutch control valve assembly (fig. 5-4). Remove the valve body assembly and gasket. Refer to paragraph 6-4 for rebuild of the splitter clutch control valve assembly.

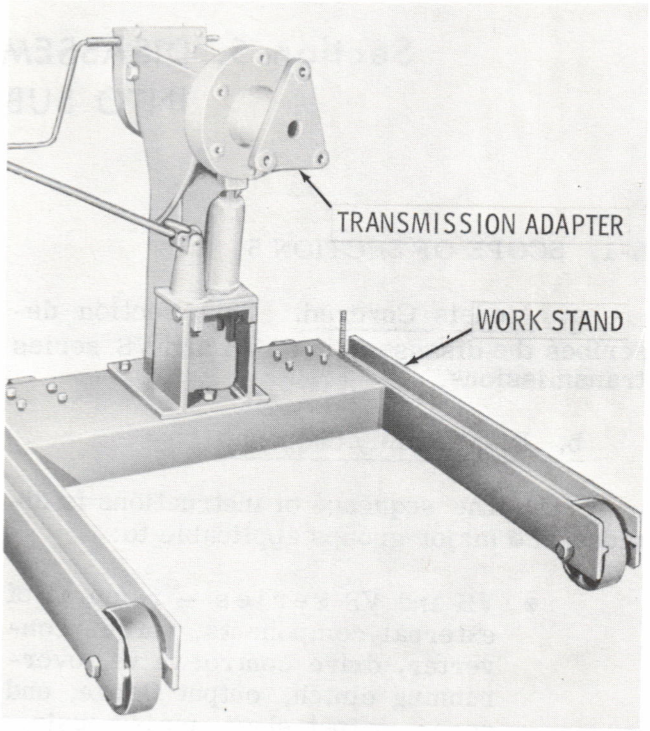


Fig. 5-2. Transmission workstand and adapter

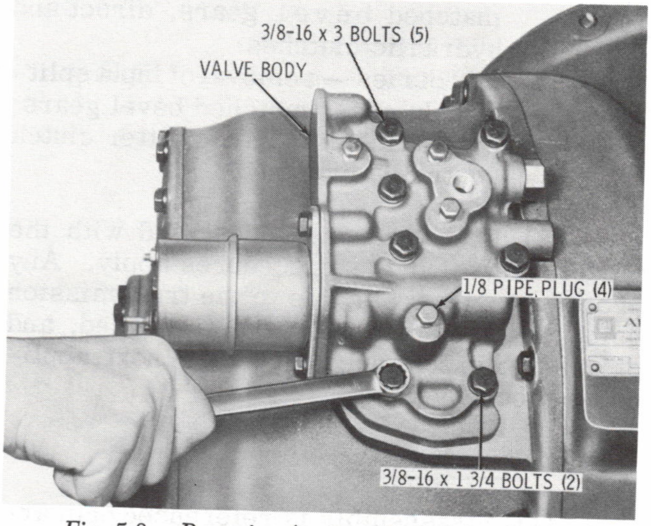


Fig. 5-3. Removing (or installing) drive clutch control valve assembly

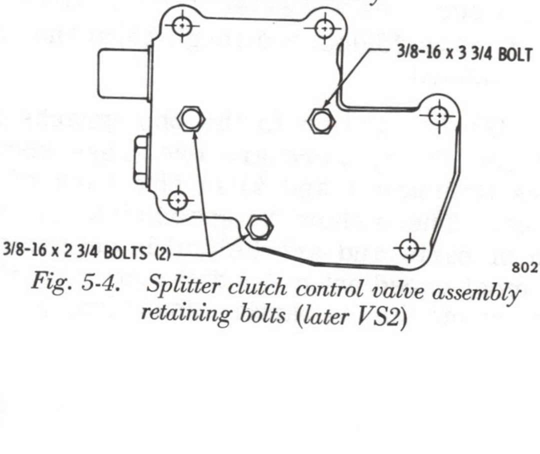


Fig. 5-4. Splitter clutch control valve assembly retaining bolts (later VS2)